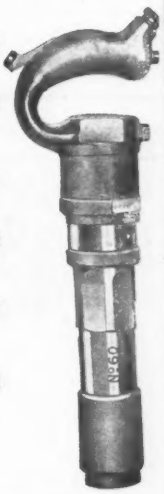
GENERAL LIBRARY,
UNIV. OF MICH.
JAN 23 1905

Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. IX. NEW YORK, JANUARY, 1905. No. 11.

Those who indulge in the Game of Boiler and Structural Work, and are fortunate enough to catch a pair like these, can continue in the Game without experiencing that nerve-racking pain when the Inspector calls.



Chicago Pneumatic Tool Company

General Offices,
Fisher Building,
CHICAGO

Eastern Offices,
95 Liberty Street,
NEW YORK

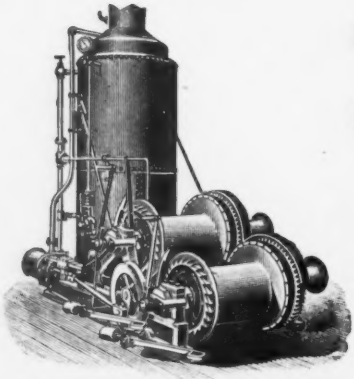
LIDGERWOOD M'F'G CO.,

Boston.
Philadelphia.
Cleveland, O.

96 Liberty Street,
New York.

Chicago.
Portland, Ore.
New Orleans.

STANDARD
High-Speed Hoisting Engines.
Built on the Duplicate Part System.



Cableways, Hoisting AND Conveying Devices,

For Canal and Trench Excavating, Dam Construction, Wall and Pier Building, Mining, Quarrying, Logging, and General Contract Work.

Fiske Brothers Refining Co.

NON-CARBONIZING OIL

FOR USE IN AIR CYLINDERS OF

AIR COMPRESSORS

Also all Grades of Lubricants for use on Machinery Propelled by Compressed Air

Office and Salesroom, No. 59 Water St., New York, U. S. A.

Cable Address:
"LUBROLEINE."

London Office:
3 MITRE STREET
ALDGATE, LONDON, E. C.

Sole Agents for Scotland:
JOHN MACDONALD & SON
GLASGOW, SCOTLAND

INGERSOLL-SERGEANT

AIR COMPRESSORS

FOR

Subaqueous Tunneling

Used EXCLUSIVELY by the

S. Pearson & Son, Inc. (Penn. R. R. Tunnels under East River).

O'Rourke Engineering & Construction Co. (Penn. R. R. Tunnels under Hudson River).

New York Tunnel Co. (Subway Tunnel under East River).

Hudson Improvement Co. (Trolley Tunnel under Hudson River).

Thirty-three Air Compressors with a total capacity of 109,684 cubic feet of free air per minute.

ROCK DRILLS PNEUMATIC TOOLS

The Ingersoll-Sergeant Drill Co.

26 Cortlandt Street,

CHICAGO, ILL.
CLEVELAND, OHIO
ST. LOUIS, MO.

NEW YORK

PITTSBURGH, PA.
PHILADELPHIA, PA.
BOSTON, MASS.

PORTER COMPRESSED AIR
MINE AND INDUSTRIAL HAULAGE.

MORE UP-TO-DATE, SAFER, HANDIER AND MORE RELIABLE AND ECONOMICAL THAN ELECTRICITY.

We introduced the first air haulage into anthracite mines, and have installed about 80 per cent. of the air locomotives in America and the majority of those in the world. We can refer to a large number of plants with one to fifteen locomotives, track gauges 18 to 56½ inches. Our designs are automatic, easily controlled and free from complications.

SPECIAL OFFER: On application of Mine Superintendent or prospective user, we will mail free our 233 page catalogue describing 600 steam and 60 air locomotives. To accommodate others a copy will be mailed on receipt of 50 cents in stamps.

Address ..... **H. K. PORTER COMPANY, - - 540 Wood St., Pittsburgh, Pa.**

THE ENGINEERING AND MINING JOURNAL is the leading mining periodical. Interests compressed air users. Subscription price, $5.00 a year, payable in advance; foreign, $8.00. Sample copies sent for the asking.

261 BROADWAY, NEW YORK.

The B. F. Goodrich Company

AKRON RUBBER WORKS. FACTORIES: AKRON, OHIO, U. S. A.

NEW YORK: 66-68 Reade Street. CHICAGO: 141 Lake Street. SAN FRANCISCO: 392 Mission Street.

Rubber Goods

OF FINE QUALITY.

HOSE FOR ALL PURPOSES.

AIR HOSE for Rock Drills, Compressors, Mining Machines, Pneumatic Riveters, etc.

ILLUSTRATED CATALOGUE.

STEAM HOSE, Etc.

Belting, Springs of all kinds, Valves, Gaskets, Rings, Packing, etc., etc.

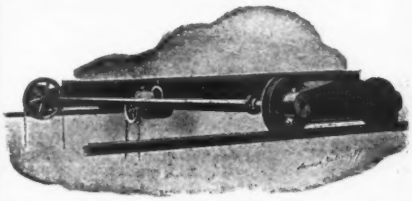
Leads and Holders

Using more colored leads than any other business house in the world, and unable to find a lead-holder that would hold and keep on holding, we invented one with a positive stop, no provoking clutch. It has stood the test of a dozen years' constant use; it doesn't wear out; the lead can't work back; it is a double-ender; it is perfection for editing copy, checking, etc. We mail it for 25 cents, loaded with two leads. We sell black, blue, green, yellow and red leads for $5.00 a gross, 50 cents a dozen, 5 cents a piece—made for us, 3 inches long, the best quality we can get. Stamps acceptable.

Luce's Press Clipping Bureau

26 Vesey St., New York
68 Devonshire St., Boston

The CURTIS SINGLE I BEAM CRANE



Pneumatic Elevators

GEARED AND DIRECT ACTING

Curtis & Co. Mfg. Co.

ST. LOUIS, MO.

LIST OF AGENTS:

The Walter H. Foster Co., 126 Liberty St., N.Y.
The Strong, Carlisle & Hammond Co., Cleveland, O.
Baird Machinery Co., Pittsburgh, Pa.
Hill, Clarke & Co., Boston, Mass.

"COMPRESSED AIR"

Published Monthly.

This is the only publication devoted to the useful application of compressed air, and it is the recognized authority on all matters pertaining to this subject.

RATES OF SUBSCRIPTION.

United States, Canada and Mexico,	per year,	$1.00
All other Countries,	"	1.50
Single Copies,		.10

LIST OF BOOKS ON COMPRESSED AIR.

Volume No. 8, Compressed Air," cloth, **2.00**

March, 1903—February, 1904, inclusive. The twelve numbers of "Compressed Air," which make up this volume are profusely illustrated with fine half-tone engravings and line cuts of a large number of important applications of compressed air.

"Compressed Air Information," Edited by W. L. Saunders, cloth, **5.00**

A Cyclopedia containing Practical Papers on the Production, Transmission and Use of Compressed Air

"Pumping by Compressed Air," by Edward A. Rix, **.75**

A practical treatise on this subject, containing valuable information, with diagrams and tables. The different systems are described and compared, and the advantages of each impartially stated.

"Compressed Air," by Frank Richards, cloth, **1.50**

Compressed Air, by Frank Richards. Contains practical information upon air compression and the transmission and application of compressed air.

"Liquid Air and the Liquefaction of Gases," by Prof. T. O'Conor Sloane, 350 pages, **2.50**

Experiments upon the Transmission of Power by Compressed Air in Paris, by A. B. W. Kennedy, F. R. S., M. Inst. C. E., Emeritus Professor of Engineering in University College, London. The Transmission and Distribution of Power from Central Station by Compressed Air, by William Cawthorne Unwin, B. S. C., F. R. S., M. Inst. C.E., **.50**

The Transmission of Power by Compressed Air, by Robert Zahner, M. E., **.50**

"Tunneling," a practical treatise, by Charles Prelini, C. E. With additions by Charles S. Hill, C. E. 150 diagrams and illustrations, cloth, **3.00**

"Transmission of Power by Fluid Pressure," by Wm. Donaldson, M. A. (M. Inst. C. E.) cloth, **2.25**

Forwarded postpaid on receipt of price.

"COMPRESSED AIR," 26 CORTLANDT ST., NEW YORK.

HEAT YOUR RIVETS
WITH
OIL
CHEAPER
QUICKER
BETTER

Send for Particulars

WE ALSO HAVE
OIL BURNERS
FOR EVERY PURPOSE

ROCKWELL
ENGINEERING CO.
NEW YORK

Rix Compressed Air & Drill Company

SAN FRANCISCO, CAL.

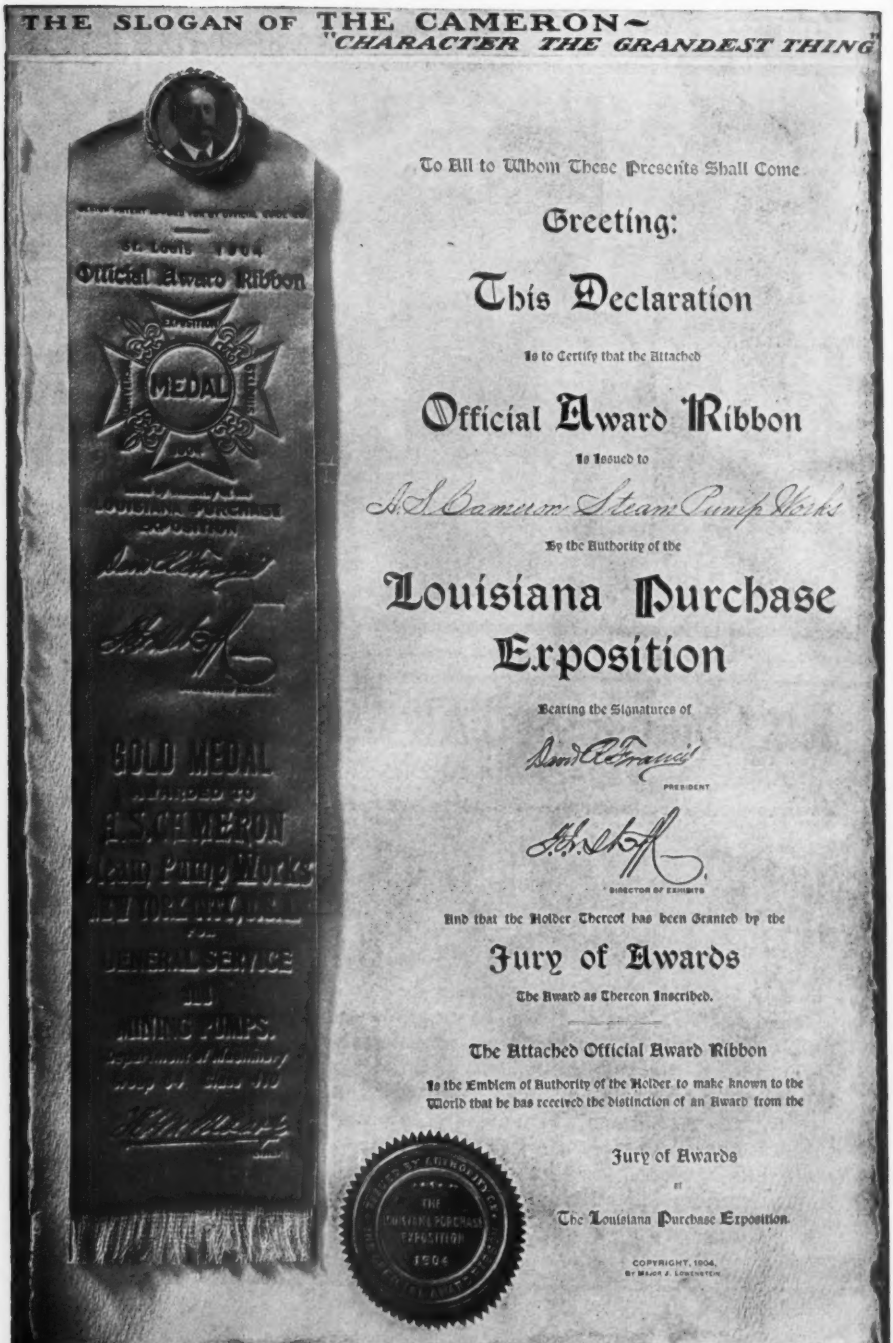
APRIL 6th, 1904.

Mr. W. L. SAUNDERS, Editor,
Compressed Air,
26 Cortlandt Street,
New York City, N. Y.

My Dear Mr. Saunders:—I must congratulate you on the very excellent work "Compressed Air Information" and I hope the engineering public will appreciate it to the extent that it will remunerate you for the care and attention you must have devoted to the book in order to present the information contained in so useful a manner.

I find it contains all necessary information upon Compressed Air subjects contemporary with its publication. I use it for reference, and on more than one occasion it has rendered me substantial benefits worth many times its price. I wish you all success.

Very truly yours,
E. A. RIX.


THE SLOGAN OF THE CAMERON~
"CHARACTER THE GRANDEST THING"
St. Louis 1904
Official Award Ribbon
MEDAL
LOUISIANA PURCHASE EXPOSITION
GOLD MEDAL
AWARDED TO
A.S. CAMERON
Steam Pump Works
FOR
GENERAL SERVICE
AND
MINING PUMPS.
To All to Whom These Presents Shall Come
Greeting:
This Declaration
Is to Certify that the Attached
Official Award Ribbon
Is Issued to
A. S. Cameron Steam Pump Works
By the Authority of the
Louisiana Purchase Exposition
Bearing the Signatures of
PRESIDENT
DIRECTOR OF EXHIBITS
And that the Holder Thereof has been Granted by the
Jury of Awards
The Award as Thereon Inscribed.
The Attached Official Award Ribbon
Is the Emblem of Authority of the Holder to make Known to the World that he has received the distinction of an Award from the
Jury of Awards
of
The Louisiana Purchase Exposition.
THE LOUISIANA PURCHASE EXPOSITION 1904
COPYRIGHT, 1904,

THE SLOGAN OF THE CAMERON~ "CHARACTER THE GRANDEST THING"

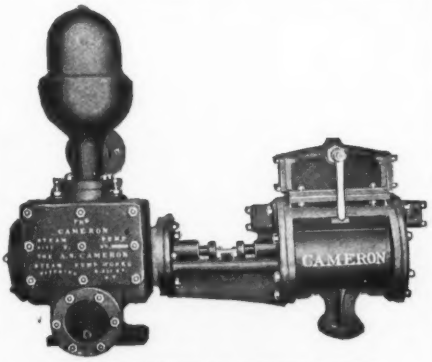
CAMERON STEAM PUMPS

Receive the Recognition due to Superiority

Conceded to be the most DURABLE, RELIABLE and EFFECTIVE on the market

The STANDARD of EXCELLENCE

AT HOME AND ABROAD



Regular Pattern for General Service

Maximum Capacity and Service with Minimum Cost of Maintenance

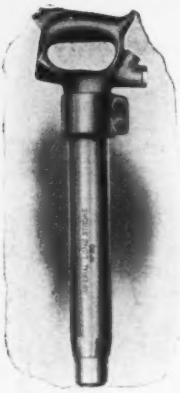
The mechanism and construction permit of abnormal speed without detriment in emergencies and under the most exacting and trying conditions

Our New and Complete Catalog ***K*** *will be sent on request*

A. S. CAMERON STEAM PUMP WORKS

Foot of East 23d Street, New York

AIR TOOLS COMPRESSORS AIR & GAS ROCK DRILLS



"Imperial"

PNEUMATIC TOOLS

THE BEST

Circular 14 describes our complete line of Imperials.

RAND DRILL CO. 128 BROADWAY N.Y.

THE only publication in the world devoted exclusively to the boiler-making industry is

— THE —

BOILER MAKER

Subscription Price,
$1.00
per year
Domestic
$1.50 Foreign
Sample Copies Free

The

BOILER MAKER

17 Battery Place

NEW YORK CITY

"Compressed Air,"

OR

THE COMPRESSED AIR MAGAZINE.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - Editor and Proprietor
C. B. MORSE, - - - Managing Editor
J. E. QUINTERO, - - - - - Treasurer

Subscription, including postage, United States, Canada and Mexico, $1.00 a year. All other countries, $1.50 a year. Single copies, 10 cents.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.

London Office, 114 Queen Victoria Street.

Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

VOL. IX. JANUARY, 1905. NO. 11

Centralization of Power Plants.

Several important installations of recent date have called special attention to the advantages in service and economy of operation offered by the central compressed air power plant. The same principles, which make the central production of compressed air so advantageous, have influenced the users of electricity and steam to consolidate their sources of power. In building the modern manufacturing establishment, this general tendency toward centralization has had an important influence in the arrangement of the power supply.

Of interest along this line is a report made by Messrs. Stone & Webster, of Boston, consulting engineers, regarding an investigation of the power plants at the Portsmouth, Boston, Brooklyn, League Island and Charleston Navy Yards. This investigation was made by the Navy Department. Four questions were submitted.

Through the courtesy of Secretary Morton, their report is summed up briefly by the *Engineering Record* as follows:

"1. How much power is there at each yard, and what proportion of it in use? How much reserve power should there be in each yard?

"This differs at each yard and will be covered as each yard is described. It is not practical to differentiate absolutely the portion of the power in each yard which may be considered reserve. In a plant with a large percentage of the maximum load due to electric dock pumps operating only for limited periods, followed by specific periods of rest, there will be actually a considerable reserve capacity when the rated capacity equals the maximum load. In general, there should be in each plant sufficient capacity so that the maximum necessary load can be carried with one of the largest units undergoing repair. The amount of reserve power necessary will vary with the size, number and overload capacity of the units in the particular yard.

"2. In a general way, how does it compare in volume with the power of other industrial plants with which you are familiar?

"In a general way the power-producing capacity at the yards is larger than similar industrial plants have for two reasons: (1) The multiplicity of power plants necessitates sufficient capacity in each to carry individual maximum loads greater in proportion than would be required if all power production were concentrated at one point. (2.) The duplication of shops of the same character, such as smitheries, joiners' shops, machine shops, etc., requires a larger power-plant installation than if work of the same character were performed at one point instead of at several.

"3. What would you do with the light and power plants in the Navy yard if you were operating the yards as private enterprises bearing in mind their military intention?

"Messrs. Stone & Webster would consolidate them at the most favorable point in each yard, placing the entire power production and distribution in the hands of one department. The details of accomplishing this require the most careful study and determination if the maximum results are to be obtained with the least expenditure. The problem is not a simple one, and is different for each yard on account of the character of apparatus already installed at both power plants and shops.

"4. If the power plants are consolidated is it possible to arrange for secondary unit supply from outside sources—that is, city supply or from private corporations?

"It is not possible to get relay service for pneumatic, hydraulic or live steam power from outside sources. Owing to the distance of the yards generally from the central station of adjacent cities and the character of the current generated at such points, it would be in general unduly expensive to transmit and convert electric power from such sources, especially in view of the relay such companies would thereby have to keep available over and above their own requirements. Messrs. Stone & Webster therefore consider it extremely doubtful if such a secondary supply would prove practicable, although in case of extreme emergency it might not be impossible. This could be definitely determined only after negotiations with the supply companies to ascertain the investment required and the yearly charges.

"Throughout their investigation Messrs. Stone & Webster had in mind constantly the fact that the Navy yards are primarily for the purpose of repairing and fitting out ships as quickly as possible in time of war—that is, the so-called military necessity of the yard—and that economy of output is not necessarily the most important requisite. They also had in mind the desire of each department to be all sufficient unto itself, thereby entailing a more widely extended distribution of different kinds of power than would be required in an industrial establishment with a locally centralized management performing the same functions."

The recommendations of Messrs. Stone & Webster are summed up as follows:

"The operations of the consolidated plant should be placed on a central-station basis—that is, it should be ready at all times day and night, to furnish an ample supply of power to any department—and should be placed in charge of men experienced in commercial central station operation, as undoubtedly a large part of the opposition that has developed to a consolidated plant is the apprehension of the different departments that they will be handicapped in their work by an inefficient or insufficient power supply, and that it will be impossible to get emergency overtime power. This feeling, which is due to the present method of handling interdepartment business, with its attendant delays, will make it necessary to so change the department regulations as to make it possible for any department head to call directly upon the power-producing department for such power and at such times as he may need it.

"No power-house machinery under order at the present time should be installed, nor any underground pipe or conduit system be extended, pending a decision as to the location and design of the consolidated plant at each yard.

"A central heating plant for all yard buildings should be projected, and as much of it be installed initially as may be economical at present as determined in connection with the working up of the details of the consolidated power plants.

"All isolated engines driving shops should be replaced by electric motors.

"Investigation should be made of the possibility of substituting the use of compressed air for a large part of the live steam now supplied, especially to steam hammers.

"Facilities should be provided adjacent to the consolidated power house for such departments as require live steam at various pressures for testing purposes, such as Equipment Department for testing generating sets, and Steam Engineering Department for testing valves, etc.

"Investigation should be made of the possibility of substituting the use of fuel oil for gas at such yards as now have naphtha gas plants.

"Better methods of utilizing for fuel purposes waste from sawmills, joiners' shops, etc., should be adopted, as a large proportion of the needs for live steam at points distant from a consolidated power plant could probably be economically supplied from such waste.

"Waste gases from furnaces should be utilized to provide steam for steam hammers, etc., where feasible.

"Investigation should be made of the economy of bringing the electrical installation of all ships to one voltage, uniform with that of the yards, in order that any ship may be supplied with current of the proper voltage directly from the mains of any yard without the intervention of motor generators, rotaries, or other complications."

The importance of this report to those interested in compressed air arises from the fact that compressed air is used extensively by the departments of construction and repair both in the shops and on board ships and the investigators would extend this use. Modern shipbuilding methods include the use of many pneumatic appliances. Neither electricity nor steam can do the work so economically or expeditiously as compressed air. It is a field where the makers of compressed air machinery have built up an important trade which promises to grow to even greater proportions.

Prizes for Advertisements.

COMPRESSED AIR is able to announce the winners in the advertising competition which was conducted by this publication for the Ingersoll-Sergeant Drill Company. There were thirty-six suggestions received and a large majority displayed special merit.

Some of the designs were very attractive, but they possessed too close a resemblance to advertisements used by others. Particular attention was given to originality, strength and character, and to attractive display.

After examining all the suggestions it was found that there were a number of practically the same excellence from which it was difficult to make a choice. The advertisement which was finally selected was chosen on account of its originality, excellent display, strength and general adaptability to the needs of the company's advertising. Mr. Fred. B. Hardsocg, of Ottumwa, Iowa, the author of this advertisement, was unable to comply with all the conditions required, so that the first prize was awarded to the second choice.

Suggestions aiming to put the name of the Ingersoll-Sergeant Drill Company prominently before the public were lacking in value. It was decided, therefore, to award no prize for these suggestions, but to give additional prizes for advertise-

ments, there being so many of the latter which merited recognition.

The awards were as follows:

First prize, $25, Wm. Dixon, London, England.

Second prize, $10, J. Frederick Tracy, New York.

Three third prizes, $5 each, Henry P. Tracy, New York; B. Wells, New York; B. Wells, New York.

One fourth prize, $2.50, Russell Knight, New York.

Remittances for these amounts have already been forwarded to the successful contestants. The suggestions will be copyrighted and used by the Ingersoll-Sergeant Drill Company in its advertising.

For the benefit of those who are interested in the competition, the Ingersoll-Sergeant Drill Company has notified us that the advertisement which was first choice in the competition will appear as the advertisement for that company in the March numbers of COMPRESSED AIR, the *Engineering Magazine, Mines and Minerals* and *Rock Products*, in the March 2d issue of the *Engineering News*, the *Engineering Record*, the *Engineering and Mining Journal*, the March 3d issue of the *Railroad Gazette* and the *Railway Age*, and the March 4th issue of the *Mining and Scientific Press*.

So successful was the contest that the Ingersoll-Sergeant Drill Company has asked COMPRESSED AIR to conduct another one on the same lines.

At least four prizes will be awarded for the best suggestions for advertisements or mailing cards. They will be as follows:

First prize	$25 00
Second prize	15 00
Third prize	10 00
Fourth prize	5 00

Each advertisement should be prepared for one of the following trade papers, designed to fill the same space as the company's regular advertisement in that paper: *American Machinist, Colliery Guardian,* COMPRESSED AIR, *Engineering Magazine, Engineering News, Engineering and Mining Journal, Granite, Mining and Scientific Press, Mines and Minerals, Railroad Gazette, Railway Age* and *Rock Products*. Strength and effective display will receive first consideration. The Ingersoll-Sergeant Drill Company reserves the right to copyright and use any of the suggestions submitted.

Particular attention is called to the fact that the contest will be open only to any firm or individual using Ingersoll-Sergeant machinery, any stockholder or employee of a company using Ingersoll-Sergeant machinery, or anyone in the employ of the Ingersoll-Sergeant Drill Company.

All suggestions should be sent to COMPRESSED AIR, 26 Cortlandt street. The contest will close April 1, and the awards will be announced as soon as possible after that time.

A Modern Quarry Plant in Mexico.

A representative instance of the growing adoption of American machinery and methods in the Mexican Republic is the recent equipment of the Hueyapam Quarries, located near the town of Otumba,

distant by about an hour's ride on the Mexican Railway from the City of Mexico. The quarries constitute but one of the many enterprises conducted on the Hacienda de Hueyapam, the property of Senor Ignacio Morales y Benitez, of Puebla. All branches of the work are being developed along modern lines. The agricultural features of the hacienda alone are of great importance, giving employment to about five hundred men and using the most up-to-date equipment. The buildings for the various departments are of substantial construction, equipped with all necessary machinery and special appliances. Quarters or homes for the employees are built on modern plans, simple but comfortable and attractive.

The properties are somewhat remote from the main line of the railway, and to facilitate the delivery of product a private narrow guage railway, about five and a half miles long has been built, connecting with the Mexican Railway at a local station. This road is thoroughly well built, and its construction offered interesting engineering problems, including heavy fills, several bridges and a cut involving the removal of over twenty thousand cubic yards of earth and rock. There is a steady down grade from the hacienda, and loaded cars descend by gravity. The empty trains are hauled back by mules. At the junction with the main line a transfer station has been erected, with powerful derricks and other facilities for the transfer of stone from car to car. The quarry product is delivered direct to private yards in Mexico City, from which it is distributed as required.

SHOWING FIRST KEYBLOCK TAKEN OUT AFTER BEING CHANNELED WITH AN INGERSOLL-SERGEANT CHANNELER, HUEYAPAM QUARRIES, MEXICO.

Owing to the scarcity of water a well was sunk at the hacienda which furnishes water for boilers and quarry machines. A depth of about 250 feet was reached and a supply secured of between nine and ten thousand gallons per day of ten hours. The well is pumped by two compound geared power pumps, one driven by an aermotor, the other by a steam engine

stone is a pale pink sandstone, remarkably fine in grain, uniform in quality and free from rocks and pebbles of harder substance. It lends itself not only to ordinary masonry work, but also to ornamental carving. Tests upon it have shown a crushing strength of 7,250 pounds per square inch, and the average weight is 137 pounds per cubic foot. Beside dimen-

DRESSING STONE BLOCKS WITH HAESELER CHIPPING HAMMER IN THE HUEYAPAM QUARRIES, MEXICO.

supplied from a 15 H. P. boiler. This same boiler furnishes steam for some of the agricultural machinery. The water is elevated to a tank about 40 feet high, from which it flows to the various pipe lines.

The quarries are located on a hill at an elevation of about 8,500 feet. The principal output is in dimensioned stone for building and monumental work. This

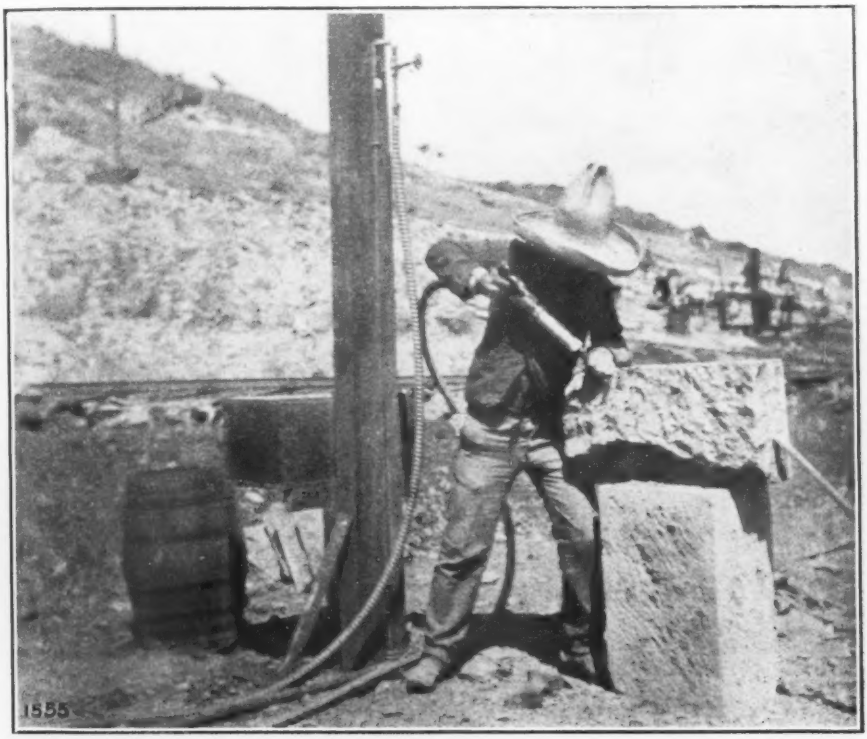
sion stone of this quality the quarries produce a high grade of "tepetate" for building purposes.

The quarry department building is a large substantial structure of the native stone, containing, beside the power plant, the offices and draughting room, machine shop, blacksmith shop, tool room, and store room for duplicate parts. On the

second floor are quarters for the engineers and mechanics. Close to the quarries a village of about a hundred and twenty picturesque modern cottages has been built for the accommodation of quarry employees and their families, laid out with sewers, water works and other sanitary devices.

capacity is 285 cubic feet per minute. This machine furnishes compressed air for the pneumatic tools, the use of which is described later. The usual complement of boiler feed pumps and other auxiliaries is a part of the engine room equipment.

Two methods of quarrying are employed —blasting, for the production of rough

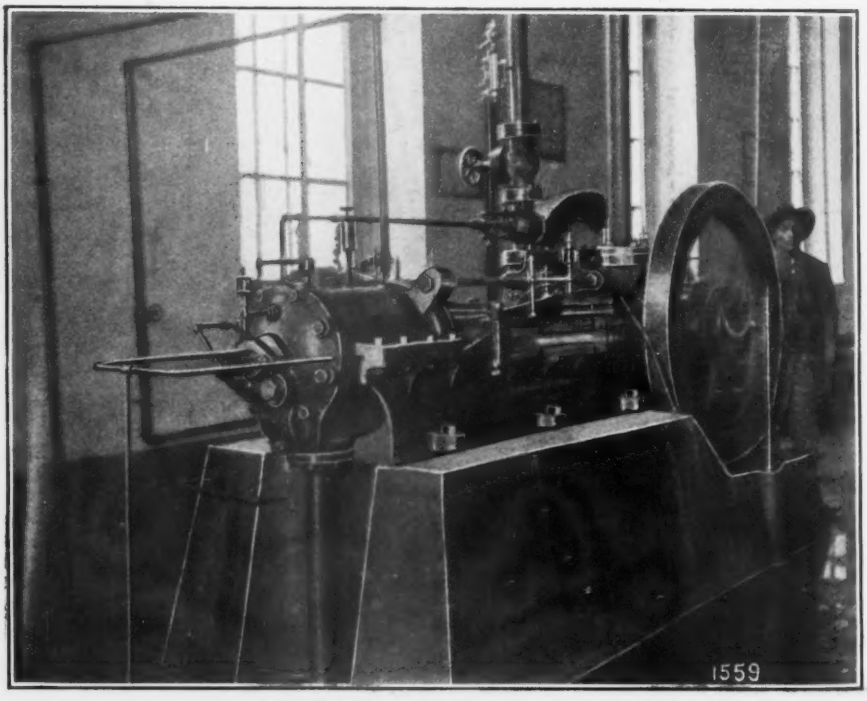


CHIPPING STONE BLOCK WITH HAESELER PNEUMATIC HAMMER, HUEYAPAM QUARRIES, MEXICO.

The power plant includes a 100 H. P. tubular boiler of English make, furnishing steam to the air compressor in the engine room, as well as to pumps, hoist, channelers and drills in the quarry workings. The air compressor is of the straight-line type, built by the Ingersoll-Sergeant Drill Company, of New York. Its cylinders are 12 inches and 12¼ inches x 14 inches. At 155 revolutions per minute its free air

broken stone, and dimension quarrying. The first method requires no description; the second merits some further consideration. Steam from the main boiler plant drives two Ingersoll-Sergeant bar channelers, making the cuts in the formation which at the present time lies at an inclination of about 34 degrees from the horizontal. In making the short cuts Ingersoll-Sergeant drills mounted on

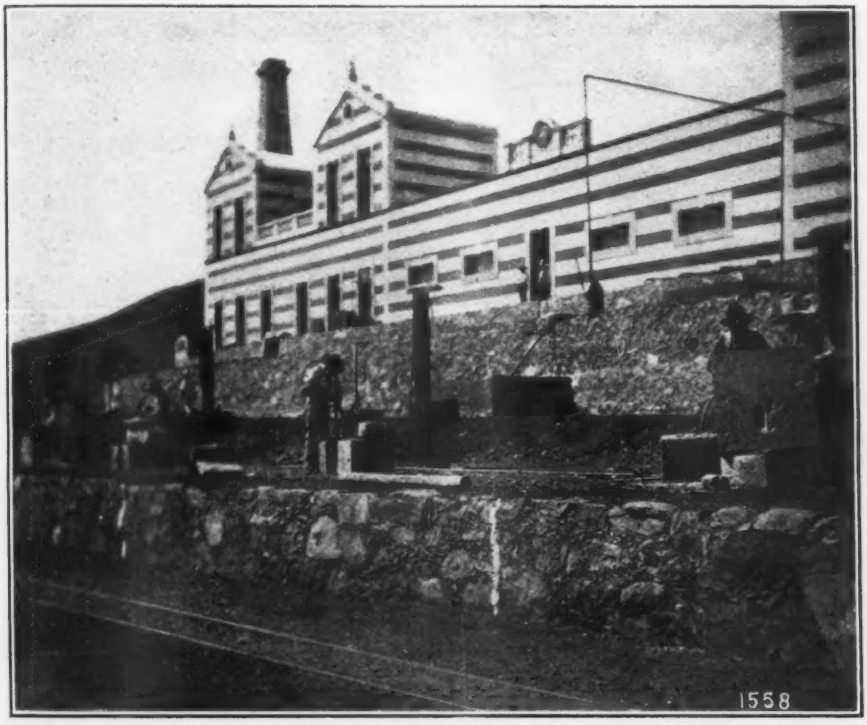
CHANNELER AT WORK IN THE HUEYAPAM QUARRIES, NEAR MEXICO CITY.



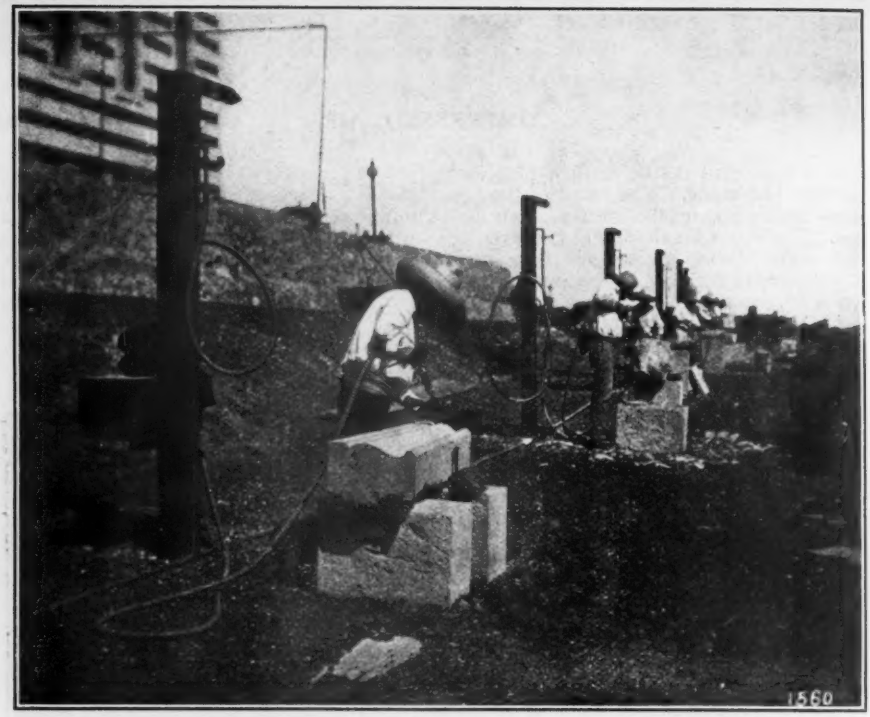
CLASS "A" COMPRESSOR AT THE HUEYAPAM QUARRIES, NEAR MEXICO CITY, SUPPLYING AIR TO OPERATE PNEUMATIC TOOLS.

quarry bars drill the holes for "plug and feather" breaking. The same method is used in loosening the blocks from the bed. The stone breaks freely and evenly; dimension blocks are secured very close to size, requiring very little trimming and handling. For handling the quarry product a tubular steel jib crane is employed, with a capacity of 10 tons at rapid hoisting speed. Dimension stone is loaded direct from quarry to car.

Extending along the front of the main quarry building is a platform, or working floor, about 300 feet long by 15 feet wide, serving as a trimming yard and loading platform for finished stone. An air pipe line runs the full length of this platform, connecting with the receiver in the compressor room. At intervals along the yard small corrugated iron shops have been built, each completely equipped with a water tank, tool chest, tools, etc., and a complement of Haeseler pneumatic tools, manufactured by the Ingersoll-Sergeant Drill Company. Branch pipes from the main line furnish air to these tools. Fourteen of the hammers are in use, of different types and sizes, adapted to the various processes of chipping, cutting, surfacing, dressing and carving. They are found to be highly economical and effective in the production of ornamental stone. All grades of artistic work are produced in this department, from the finest carving in low and high relief to the heaviest columns, capitals, cornices and pilasters. The use



MEN AT WORK ON STONE BLOCKS WITH HAESELER PNEUMATIC TOOLS IN FRONT OF ENGINE AND TOOL HOUSE IN THE HUEYAPAM QUARRIES, MEXICO.



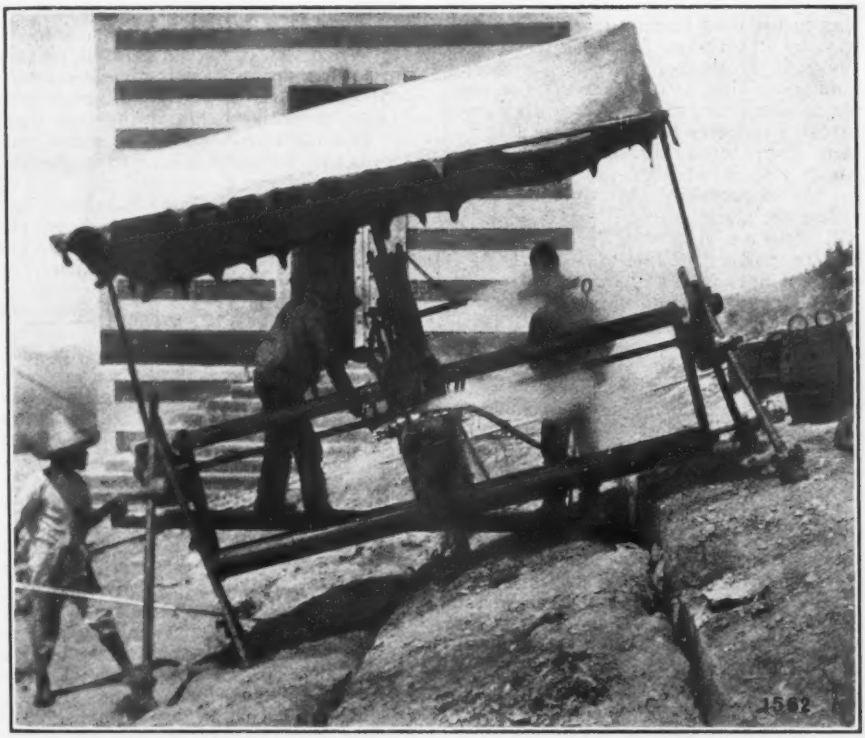
DRESSING AND CARVING STONE WITH HAESELER PNEUMATIC TOOLS IN THE HUEYAPAM QUARRIES.

DRESSING BROWNSTONE BLOCKS WITH HAESELER CHIPPING HAMMERS, HUEYAPAM QUARRIES, MEXICO.

of the pneumatic tools assures a product of highest quality and finest finish. A spur of the railway runs beside the platform, making easy the loading of finished stone.

Beside the quarry just described, development is being made in a deposit of very high grade "tepetate," which has shown remarkable qualities under test and is being placed on the building materials market. An extensive deposit of black sand is also being opened up and placed on the market for use in concrete work. This sand is of volcanic origin, is sharp and of high binding quality. Another enterprise, somewhat kindred to the quarry development, is the production of brick, terra cotta and roofing tiles. For this work an extensive system of ovens is being installed, each chamber to have a capacity of twenty thousand pieces.

This application of modern machine methods in every department of a great enterprise is a conspicuous proof of the awakening which has come to the land of the Montezumas. The entire productive plant is a direct response to the call for high class building materials arising from the enormous growth of the Republic's capital city. The improved quality and low productive costs of the various products of the Hueyapam quarries will doubtless command the best market in the structural field of Mexico.



CHANNELER AT WORK ON HILL SIDE IN THE HUEYAPAM QUARRIES, MEXICO.

(The awning over the Channeler is to protect the operator from the sun and rain.)

Logging Operations by Compressed Air and Steam.

Our Minneapolis contemporary presents the following very interesting account of a new invention or logging by compressed air:

The felling of timber and cutting it into logs by compressed air, then skidding the logs to the road hauling them to the rollway, by steam power, is the gift of H. B. Frey, of Minneapolis, to the lumbering industry. This new invention is a complete system for logging, which, to a great extent, eliminates horses and the labor of men from lumbering operations in the woods. It is adaptable to any country, to any topography, the mountain, the valley, the plain and the steep hillside. It will operate under all conditions of climate, and in all kinds of weather. It matters not whether snow is on the ground, or the ground covered with summer's carpet.

The first detail of the system, to begin with the first step in logging operations, is the mechanism, driven by compressed air, which saws down the trees and then cuts them up into logs. This consists of a cross cutting saw, adjusted to an arm, which is fitted with a system of cylinders and pistons, acted upon by compressed air. The saw is brought to the tree or the log, by what is known as the shot-gun feed action in sawmills, only in this instance the saw is brought to the log instead of the log to the saw. The entire mechanism is mounted upon a truck or sleigh, of the ordinary size. This is hauled to the tree. The saw is then speedily adjusted to any angle desired to attack the tree, and after it is felled, the saw is moved alongside and the tree is quickly sawed into logs. There are movements and combinations of positions which permit the saw to adjust itself to a large tree standing on a side hill, on the level ground, or down in a declivity. These changes of position are made without the least hindrance, and can be secured almost instantaneously. The compressed air tanks are supplied by a gasoline engine, and these are mounted, together with the saw upon the same vehicle.

The log hauling and skidding device is a combination of a steel cable and pulleys, driven by steam. For hauling logs a steam upright engine is set upon a sleigh. The drive wheel is also mounted upon this sleigh, and is directly attached to the engine. A steel cable is made fast at each end of the logging road, along which the haul is made. This cable lies along the middle of the road, passes up under the sleigh and is coiled four times around the drive wheel. When this wheel is set in motion by the engine, the slack in the cable ahead of the sleigh is immediately taken up, and the sleigh pulls itself forward. The same thing takes place to the rear when the engine is reversed, and the sleigh then moves backward. The sleighs bearing the logs to be hauled, are coupled to the locomotive sleigh, in the same manner as a train of cars, and the entire train moves easily along the road to its destination. About the curves the cable is kept in its place in the middle of the road by a system of trips, which drop down and permit the sleigh to move over them. The engine is of thirty-five horse power. It requires eight horse-power to move the machine, all fueled and watered to run, thus leaving twenty-seven horse-power for the load. For skidding, the engine is made stationary, and the cable is converted into a live cable by passing it about a system of upright rollers, stationed at the angles. This cable is carried about in the woods where the logs have been cut. By means of a clamp, the short chain, which is attached to the log, is fastened to this live cable and dragged to the skidway.

In the different details of the invention Mr. Frey has brought out a remarkable series of original ideas, all of which harmonize to produce a complete and practicable system for speedy handling of logs from the timber to the end of the logging road. This new invention will be manufactured by the H. B. Frey Company, recently organized in Minneapolis. The concern is capitalized at one million dollars, and the incorporators are H. B. Frey, John F. Nichols and Ervin B. Frissell, all of Minneapolis.—*The Lumberman.*

Compressed Air in Mine Operation.*

Present-day mining is no longer looked upon as a game of chance, and the miner has ceased to be regarded as a devotee of the fickle goddess of Fortune. A mine is now recognized as a productive business

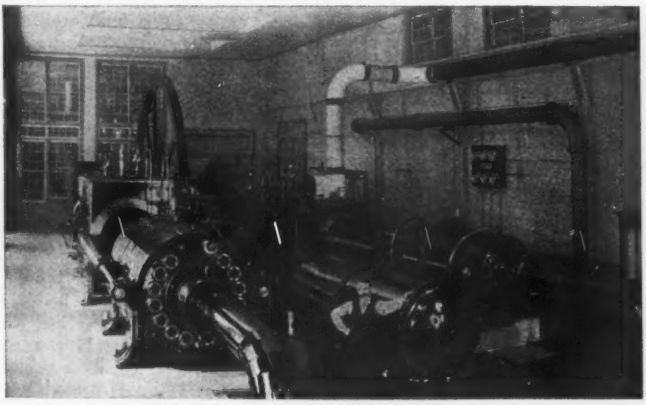
*By Lucius I. Wightman, E. E., in the *Mining Magazine.* Illustrations published through the courtesy of the *Mining Magazine.*

enterprise, and its organization must be a productive organization.

The problem is that of securing a finished product from a raw material, with the minimum productive expense. The known quantities are the cost of labor and of power. The predominant tendency in modern production is toward the substitution of machine methods for hand labor, bringing into greater prominence the agents and the machines by which the substitution is accomplished, and raising to first place the importance of power in productive enterprise. The tendency is as strong in mining as in manufacturing, and with its growth the attention of the mine manager is more and more occupied with the problems of securing and applying power for the operation of his mine.

This paper is neither a comparison nor a discussion of the various forms of power available, its attitude being clearly stated in the title at its head. It is an open advocacy of compressed air for mining work, but the facts presented may serve as a basis of comparison to those undecided between the various forms of power available. At the outset, let it be remembered that compressed air is *not* a motive power, but simply an agent through which some one of the common forms of motive power is applied to secure, through the aid of mechanical devices, a given result hitherto attained by hand labor. The subject will be best treated in the logical order of its division into production, distribution and application.

Steam, water power, electric power and gas are all applicable to air compression and they are mentioned in the order of their general adoption. The steam-driven air compressor is a standard and has shown its value and reliability in a thousand mines. But the economy of the steam-driven compressor is dependent upon two things—the cost of fuel and the type of steam and air-valve gear. The first, of comparative unimportance in coal mining districts, is often an item of appalling magnitude in metal mining plants.



THE LARGEST CORLISS AIR COMPRESSOR IN THE WORLD,
HOMESTAKE MINING CO., LEAD, S. D.

The second is usually determined by the size of the plant; the larger the plant the greater the mechanical refinements required. To these may be added a third, the cost of boiler water, which in many instances assumes proportions scarcely secondary to the first.

The excessive power cost often imposed by these conditions has led many companies to turn to sources of natural power in proximity to their properties. Water powers have frequently been developed and their energy applied to air compression—either directly, in a plant located at the falls, or indirectly, through the agency of electric conversion and transmission. The electric-driven air compressor, though a comparative stranger in the min-

ing field, has met with a cordial reception and attained the highest success. On the grounds of simplicity, reliability and high economy, it is unquestionably making a place for itself in mine enterprise. The gas-engine-driven air compressor has found a certain field of usefulness in small and isolated plants, but has not yet become a factor in large units. The tendency in the past has been to use almost any type of compressor at the mine, but with the growth of business methods in mining greater attention has been given to small economies, and the tendency now is toward compressing machinery of highest efficiency and mechanical refinement.

The distribution of air from compressor to working face has been a feature too

COMPRESSED AIR DRILL IN OPERATION AT GATE CITY, ALA.

often slighted in the lay-out of a mine, yet it is a most important factor in the plant economy and is deserving of the best attention. Large receiver capacity is of fundamental importance in maintaining a uniform pressure on machines and, acting as an accumulator, in relieving the compressor of shocks due to sudden load fluctuations. It is almost impossible to have too much receiver capacity and old boilers can be worked in to advantage along the lines. There is never any justification for the use of air pipe too small to be of good service—a mistake too often made and repeated. Pipe sections should be such as to permit everywhere a moderate velocity of flow, for drop in pressure due to pipe friction is a loss almost as serious as that from leakage. A difference of pressure of from three to five pounds between receiver and working face should be the maximum allowed, and a properly laid-out system of piping will show no appreciable loss of pressure.

A pipe line laid over an irregular surface is full of possibilities of lost power and should be supported against sagging strains due to its own weight; it should be securely anchored as a precaution against "creeping" and strain of joints and the possibilities of expansion and contraction everywhere provided for. These are indispensable safeguards against leakage, and the volume of good live air which a small leak will discharge is startling. Tests on mine pipe systems, supposedly in good condition, have shown leakage losses of 25 per cent., 30 per cent. and even 45 per cent. of the compressor output. When a compressor, apparently ample in capacity, refuses to operate the required number of machines, the shutting down of all machines will often reveal a condition which will bring tears to the eyes of the careful manager. A well-designed distribution system should hold working pressure on the receiver over night, with the compressor idle, and a 5 per cent. loss should be the utmost limit of leakage allowed. Judgment should also be used in arranging the grade of the line. Pipes should grade toward secondary receivers at the lowest points and drain cocks should discharge accumulated moisture. An intelligent consideration of this point will save hours of troublesome relay and much unchristian language attendant upon the removal of ice from drill exhausts and other discharge ports.

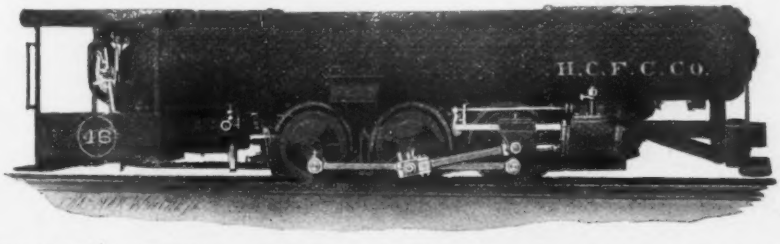
Small in size, but vast in its possibilities, the rock drill stands first among the applications of compressed air to mining operations. The rock drill made possible the mine of to-day, and the superior economy and effectiveness of machine over hand methods are no longer questioned. The only question at issue is the type of drill to be used, and this all-important point is too often determined by the conversational and convivial prowess of a salesman, rather than by the merits of the machine itself. Probably no machine tool is more severely abused than the rock drill and this very fact suggests sturdy strength and hardy durability as essentials. These in themselves call for the greatest simplicity of mechanism. The fewer the parts, the

simpler their form, and the stronger their material, the better. The drill which uses the least volume of air per minute is not necessarily the most economical. The only true measure of drill efficiency is the volume of air required per inch of hole drilled. Judged by this standard, some of the so-called efficient drills must retire in favor of the older types of air consumers which are blessed with the happy faculty of driving the steel into the rock.

Mine operation may be said to consist essentially of the breaking and moving of the excavated material. In the mining of metal-bearing ores, the rock drill is the all-important feature of the first process. It has its place, too, in coal mining, but is aided by the mechanical coal cutters of various types—pick, chain, radial, etc.—

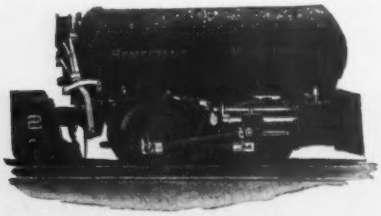
PNEUMATIC COAL CUTTER IN OPERATION BY THE KEYSTONE COAL AND COKE COMPANY, KEYSTONE, W. VA.

which require no description here. They all have their fields of usefulness, in which their merits are acknowledged, and they have done yeoman's service in helping to eliminate the uncertainties and extravagancies of hand labor. In their operation compressed air has been, and will continue to be, the only safe, satisfactory and economical agent. It has as yet no rival.



THE LARGEST COMPRESSED AIR MINE LOCOMOTIVE YET BUILT. WEIGHT 40,000 POUNDS.

The second process of mine operation—the moving of the material— includes load-



THE SMALLEST COMPRESSED AIR MINE LOCOMOTIVE IN OPERATION. WEIGHT, 9,500 POUNDS.

ing, tramming and hoisting. A successful machine loader is as yet one of the attractive dreams of the inventor. In a few large tunnel enterprises, attempts have been made at mechanical loaders operated by compressed air, but the scrap-heap has been their resting place. Here, at least, compressed air has bowed in defeat before the sturdy arm and the good shovel of the workman. Yet the trouble lay in the mode of application, not in the power used.

In the problem of hauling mine products, the compressed-air locomotive has been widely used and has shown itself equal to all demands. Its greatest usefulness, however, has been in the coal-mining field, where the wide galleries and rooms, the heavy trains and the long hauls have been favorable to its economical use. In metal mining, conditions have not been so encouraging, for the drifts of the average mine are narrow, the turns abrupt, the hauls short, and the output of the ordinary mine of this class can be handled in single cars. As these mine operations increase in magnitude, drifts and entries will grow in length and will be enlarged to suitable dimensions, cars will be run in

TYPICAL MAIN HAULAGE COMPRESSED AIR LOCOMOTIVE, MILL CREEK COAL CO., NEW BOSTON, PA.

trains, and doubtless the compressed air locomotive will receive due recognition as a factor in mine economy. Until that time, the hand-pushed car will deliver the output of the average metal mine. Meanwhile, in the larger metal mines, with local mill plants, the air locomotive is proving of great value in handling cars between shaft and mills, in the surface workings of the mine.

Compressed air for hoisting has long since passed the doubtful stage. For large surface hoists steam still holds the field against all, but in underground workings—at winzes, up-raises and short inclines—the hoister driven from the air line has successfully discharged its duties. In these locations, far from the surface, steam is forbidden by the loss in transmission; the fumes from a gasoline hoist prohibit its use; and electric power is probably not available. But if an air pipe is at hand nothing else is necessary. As mines develop and cost of fuel increases, compressed air for hoisting will receive more general adoption. The large air hoist, taking air from a high-grade compressor plant, driven directly or electrically from a water power, will certainly show an economy higher than that of a steam hoist with high-priced fuel and water, and will compare favorably with the direct electric hoist. But it will have to be properly designed and reheating must secure the economies of expansive working. This is one of the problems which will, sooner or later, confront the mine engineer, and when he faces it, he will find the pneumatic engineer ready and able to aid in its solution.

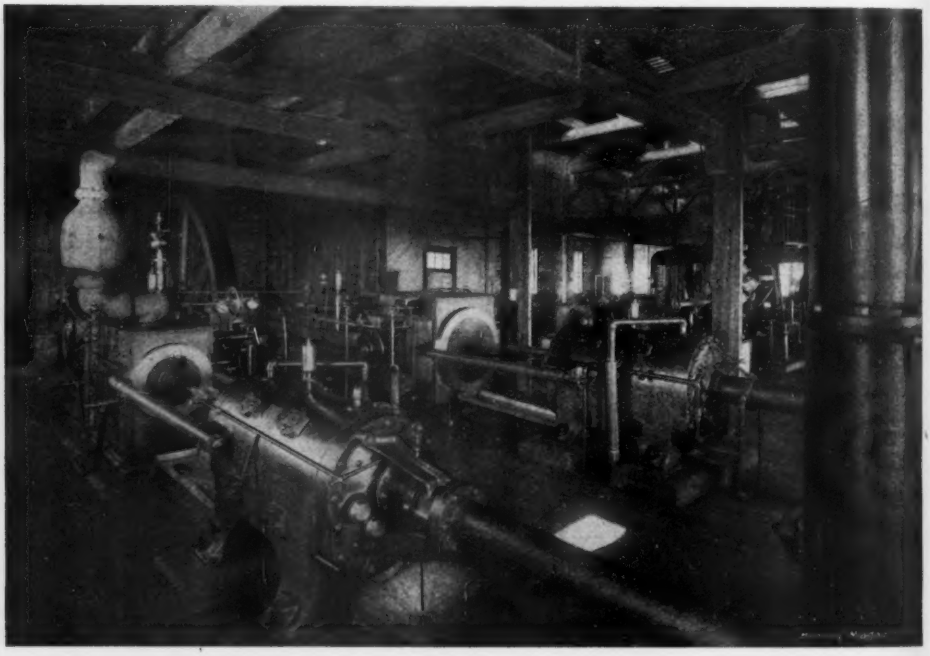
ROPE-DRIVEN AIR COMPRESSORS, REPUBLIC IRON COMPANY, REPUBLIC, MICH.

There are some operations in mining which cannot be classified under the two fundamental subdivisions adopted above. One of these is the removal of water by pumping. The same advantages recommending compressed air for underground hoists, qualify it for station and sinking pumps in the mine workings. Air will

show an economy in pumping at least as high as that of steam, when the transmission losses of the latter are considered. It requires no specially designed pump and operates faithfully regardless of moisture and dirt and even under water. The same is true of air when applied to mechanical ventilating devices, fans, blowers, etc.

In the minor operations of an active mine, compressed air is ever finding new applications. There is perhaps no such all-around handy tool as the pneumatic hammer and its modifications. In cutting "hitches" and in trimming the walls of shaft, tunnels and drifts, these little giants have been found wonderfully useful. In the surface workings, with an air pipe leading to the timber yard, the pneumatic chisel aids in framing the timbers, the pneumatic rotary bores the bolt-holes and the pneumatic hoist swings the timbers from pile to rack and from rack to car. In the blacksmith shop, a small air pipe replaces the bellows at the forge and another connects to the drill-steel sharpener which supplies the steels for the machines below. In forge and repair shops, an air-driven trip hammer does the heaviest forging, while air hoists lift and swing the work from tool to tool. From a well adjacent, an air lift, perhaps, raises to the surface the water for the plant. Compressed air is a subtle agent and has a way of creeping into corners of usefulness hitherto unimagined.

The manifold advantages of compressed air in mining can here be given but the briefest summary. First of all must be placed its limitless flexibility, its adaptability to every phase of mining work. There is but one thing impossible for it—it cannot light the mine. But a small direct-connected generating set, air-driven, offers a solution of this difficulty when compressed air is cheap enough. The ease and economy of air distribution and application is another strong recommendation. On the score of safety no



STEAM-DRIVEN COMPRESSED AIR PLANT OF THE PENN MINING COMPANY, VULCAN, MICH.

criticism can be offered, either in the production, distribution, or application, for the exhaust from air machines is a positive boon in the cramped workings of a mine, the cool, fresh air bringing life and vigor to the miner and driving out the pungent powder fumes. Formerly "anything was good enough for a mine," but the introduction of business methods sounded the death knell of this medieval policy. To-day simplicity, reliability and economy are the fundamental requirements of the mine equipment and the best is required in design, material and workmanship. Makeshifts are no longer tolerated and the compressed air machinery of to-day meets the business demands of progressive mining policy.

The role of the prophet is one without honor and the present paper must close with only a suggestion of possibilities. The future of compressed air in mine operation lies along the lines of general application already laid down. The pioneer work has been done, the trail blazed, and it remains for the bold and progressive engineer to advance along the path already marked. Future advances will result in greater economies—economies in production, distribution and application. In production, cheaper power and improved design in motive and compressing machinery will reduce the cost per unit volume of air compressed. In distribution, the alluring possibilities of the "return pipe" or "closed circuit" system will be developed to the utmost. In application, improved design will add to machine effectiveness and new types will be found. The use of reheaters—open, for surface working, and internal combustion, for underground work—will secure greater economy through expansive use of the air. Higher air pressures will secure more efficient compression, render more effective the working tool, and increase the commercial efficiency of the entire installation. Advancement in mine methods, operation and management will be secured only by careful study of the lines of present compressed air practice, aided by a readiness to branch out along new lines as they are suggested by sound theory and approved by stern engineering judgment.

The Compressor Stuffing Box.*

The success of the metallic packing for steam engines induced Friese to try the same for compressor stuffing boxes, especially as the use of metallic packing seemed to be the means of omitting the continuously operating oil pump, as well as the lantern, both of which were the principle features of the "Linde" stuffing box. "Friese's" metallic packing consists of two spirals of triangular cross-sections, one within the other. The inside spiral, *a*, Figure 7, consists of soft white metal, and its flat face forms the wearing surface on the piston rod; the outer steel spiral, *b*, fits loosely into the stuffing box bore and the gland, *c*, exerts the necessary pressure to cause the white-metal spiral to hug the piston rod snugly. Gland, *c*, contains the oil chamber and an ordinary oil cup, *d*, supplies the lubricating material. The outer packing rings, which face the gland, are made of a soft rubber composition and form a cushion between the gland and the spiral packing rings. The principle of a lantern, however, with an oil chamber in the centre of the stuffing box has been so successful that numerous efforts have been made to combine the lantern with the advantages of a metallic packing. None of these latter efforts has been a decided success and several constructions embodying the above combination have been abandoned.

The Vilter Company's Style.

One of the most elaborate stuffing boxes is used by the Vilter Manufacturing Company in connection with their double-acting compressors. Owing to the extremely searching and penetrating character of ammonia the stuffing box is equipped with a full set of metallic packing rings, a very long oil sleeve and another set of "Garlock" packing, the latter being held in position by an ordinary follower in connection with the outer stuffing-box nut.

It will be noticed that this stuffing box, as well as all the others which have been described above, has as the final outer packing a set of soft packing. These soft packing rings absorb the oil until they are thoroughly saturated; in this condition they provide a means of lubrication for the rod

*Continuation of a serial article by J. C. Goosmann, M. E., in the *Cold Storage and Ice Trade Journal*.

and act as a seal against the escape of ammonia at the same time. The manufacturer claims as an additional advantage for this stuffing box that it is possible to operate the compressor with a suction pressure higher than the ordinary in consequence of the advantageous effect of the oil sleeve, which increases the efficiency of the machine provided the required evaporating temperature allows the carrying of a high suction pressure. It is also stated that the glands and the stuffing-box nut, which are for the purpose of taking up the packing rings, may be kept comparatively loose, so that the friction on the rod is reduced to a minimum, while no ammonia can be detected by smell at the outer end of the stuffing box.

end. The support is mounted substantially to the frame and its bore is used as a shell for the sleeve as well as for the outer "Garlock" packing with follower, *d*, and outer stuffing-box nut, *e*. The principal disadvantage of this stuffing box is its length, and the fact that a number of additional separate parts require considerable care in order to keep them in proper alignment. It is said, however, that this stuffing box has performed its functions satisfactorily for many years.

The "Triumph" Stuffing Box.

The "Triumph" stuffing box contains the "Linde" oil lantern, and it is packed similarly to the "Linde" stuffing box. The means of lubrication are different,

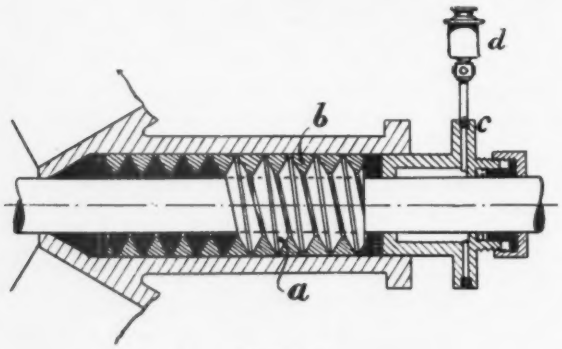


FIGURE 7.

The stuffing-box piston rod is packed with a number of self-adjusting metallic packing rings, *a*, Figure 8. Next to these are placed a number of "Garlock" rings, forming a cushion between the metallic packing and the metallic oil sleeve. The latter, *b*, is about 15 inches long and contains an oil pocket nearly its entire length. Sleeve, *b*, compresses the metallic as well as the inner "Garlock" packing by means of rear nut, *c*, and is provided with a number of slots near its outer end for the purpose of oil circulation as shown in Figure 8. An automatic oil pump circulates the lubricating oil through the sleeve, and as the body of oil through which the rod passes is large, it affords an excellent opportunity to cool the rod. On account of the extreme length of the stuffing box it is necessary to support same at the outer

however. Instead of using the automatic oil pump, this construction has a drip oiler, which furnishes the oil for the outer oil seal. In order to afford ample chance for cooling of the rod the oil pocket is of considerable length, and the sleeve, Figure 9, containing the pocket, serves at the same time the purposes of a follower to compress the packing rings. A hand-pump keeps the lantern under oil, and any overpressure of ammonia gas may be returned to the suction side through valve and connection. Large compressor units are nowadays usually constructed of the tangye-frame pattern; in that case the accessibility to the stuffing box must receive special consideration, as the failure to provide this convenience is sure to be a serious detriment to the proper regulation of this important part of the machine.

De La Vergne Machine Company's System.

The well-known "De La Vergne" oil system which has been used by them for many years for the effectual sealing and lubrication of the stuffing box of their vertical double-acting compressor is of especial interest.

The oil for cooling, sealing and lubricating is brought to the compressor by a pipe running along the back of the frame. Two separate means are used to supply the oil, one of which is a pipe connection to the lower part of the oil separator, the other being either a hand or automatic pump to furnish any eventual deficiency of oil from a special tank.

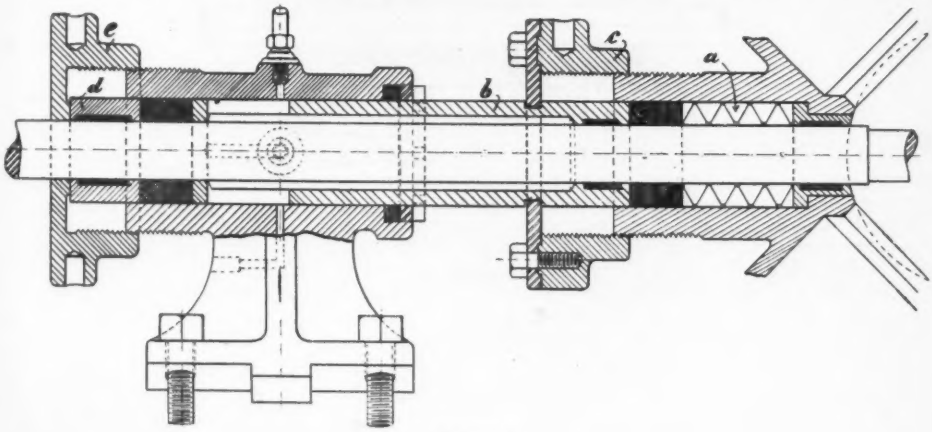


FIGURE 8.

Interposed in the line from the oil separator to the stuffing box is a oil strainer to prevent the entrance of any impurities to the stuffing box. The oil is forced into the bottom of the cylinder around the piston rod. On the downward stroke, this oil being under the discharge pressure, seals the stuffing box thoroughly. A small part of the oil is discharged with the gas and enters a special fore-cooler; here the oil separates from the gas and is deposited in the oil trap to be returned to the stuffing box through the connection mentioned above. Much has been said pro and con of this oil system; there seems to be no doubt, however, that it has been a success in every case when handled by a competent engineer, and the reason for abandoning same seems to be rather the additional cost of construction in these times of sharp competition, than any unsatisfactory results, as has been claimed.

The stuffing box of the horizontal "De La Vergne" compressor again approaches the principle established by Linde. There we have again the "Linde" oil lantern as shown in Figure 10. The oil is supplied under pressure from the oil separator; it passes the strainer and enters the stuffing box at the lower point. Directly above the stuffing box and on the same line of oil communication is mounted the oil pot. "Bulls eyes" located on the sides of the oil pot show the amount of oil contained in same. A needle point valve on top of the oil pot and a pipe connection to the suction side of the system allow the release of any pressure of gas superior to the prevailing suction pressure into the suction side. It is clear, therefore, that the oil pressure in the stuffing box must be slightly higher than the suction pressure; it can never be less than the latter at any rate. With a high-suction pressure and a heavy "freezing back" to the machine, it may happen that quantities of liquid ammonia are carried into the lantern by means of the piston rod. This liquid ammonia evaporates into the oil pot, and if present in sufficient quantities may freeze the oil or else freeze the oil-saturated packing rings, which would spoil them. In order to prevent such occurrences it seems to be advisable to interpose a second lantern, as

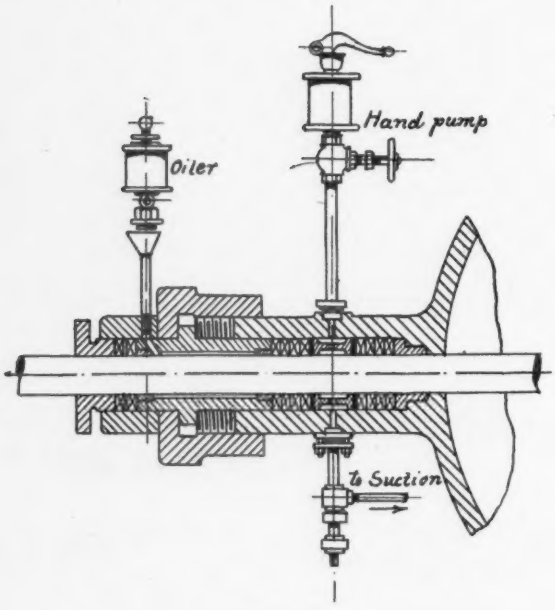


FIGURE 9.

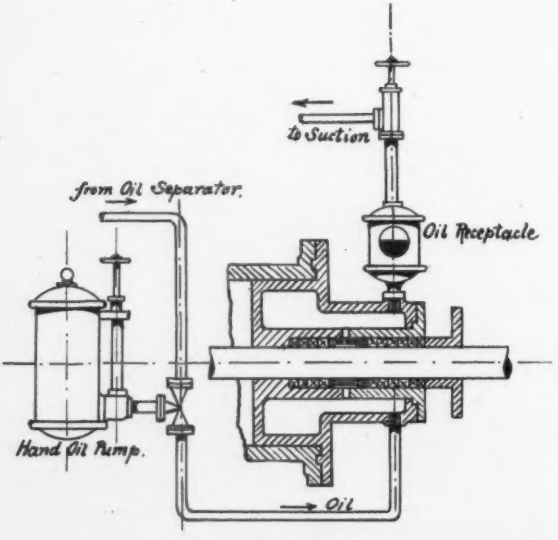


FIGURE 10.

shown in Figure 11, merely for the purpose of forming a pocket for any liquid ammonia that may be carried into the stuffing box. It would be necessary in this case to provide a pipe connection between lantern and the suction side so that

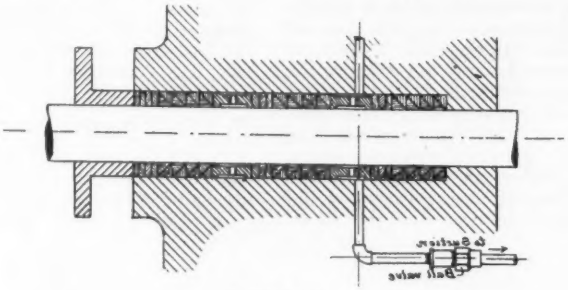


FIGURE 11.

the ammonia may be expelled before it gets a chance to be carried further into the lantern. A simple ball valve must be interposed in pipe line to prevent the free passage back and forth of the gas, or the valve may be so constructed as to maintain a pressure considerably above the suction pressure in the lantern, so that the first set of packing would be subjected only to the pressure difference between the high-compression pressure and the pressure maintained in the lantern, which has proved of great advantage in high-pressure stuffing-box construction. As soon as the first set of packing starts to leak it will be noticed immediately by the increased temperature of pipe connection, and in most cases by the noise of the "leak gas" passing through this connection as well.

STETEFELD'S PATENT ARRANGEMENT.

Mr. Richard Stetefeld, the well-known German refrigerating expert, recently obtained a stuffing box patent which is based entirely upon the idea of maintaining pressures ranging between the high and the suction pressure in the stuffing-box lantern and which may be regulated at will. Lantern, *a*, Figure 12, is connected with the liquid line by means of expansion valve, *d*, and pipe connection, *b*, on one side; expansion valve, *e*, and pipe connection, *c*, provide the connection with the

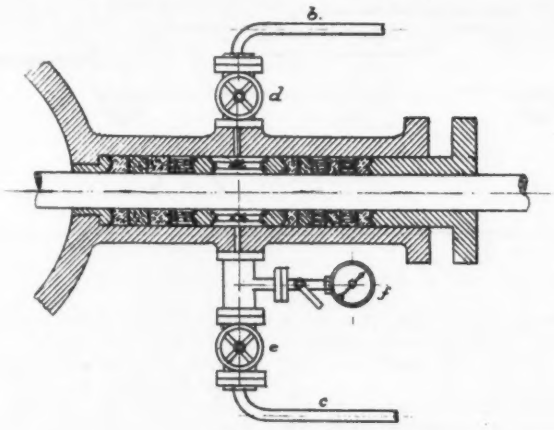


FIGURE 12.

suction line on the other side. This arrangement enables the operator to maintain in *a*, any desired pressure within the evaporator and the condenser pressure, simply by manipulating the valves, *e* and *d*. Gauge, *f*, indicates the pressure in *a*, which is likely to fluctuate and will require frequent readjustment. In the case of heating of the stuffing box it may be easily cooled by allowing the evaporation of liquid ammonia through the stuffing box into suction connection, *c*. The practical engineer is likely to consider this stuffing box of a merely theoretical nature. In order to maintain an average pressure in lantern, *a*, the regulating valves would require constant attention, and the freezing of the stuffing box in the case of a heating tendency harbors many dangers and does not remove the causes of the heating.

With the introduction of carbonic acid refrigerating compressors, the problem of a suitable stuffing box, which had been satisfactorily solved in the case of the ammonia machine, again confronted the constructor, owing to the much higher pressure required with this system. The piston rod of this machine is large in diameter as compared with the size of the piston, which is due to the small bore of carbonic acid compressors, and on that account the task of preventing gas leakage through the stuffing box in the case of a double-acting compressor seemed well-nigh impossible. Therefore double-acting compressors were temporarily abandoned and a single-acting, two-stage compressor took its place. This machine worked with plunger pistons in the low, as well as in the high-pressure cylinder and the stuffing box was constructed on the lines of the patent by Dr. W. Rayett.

The Rayett Stuffing Box.

Figure 13 represents the "Rayett" stuffing box in connection with the high-pressure cylinder of the said CO_2 compressor, *a* is the plunger, which is provided with inside water cooling by means of water inlet and outlet *b* and *d*. A number of soft packing rings, *r*, are held in place by gland *g*. The latter is provided with a large gas chamber, *f*, and the leak gas passing into same leaves the chamber through pipe connection *h* and is forced back into the cycle of the system by means of a small auxiliary compressor. The necessary lubrication enters the gas chamber at *k*. As a compressor for refrigerating purposes this machine did not hold its place very long. It is, however, still in use for compressing the CO_2 from the atmospheric up to the pressure of liquefac-

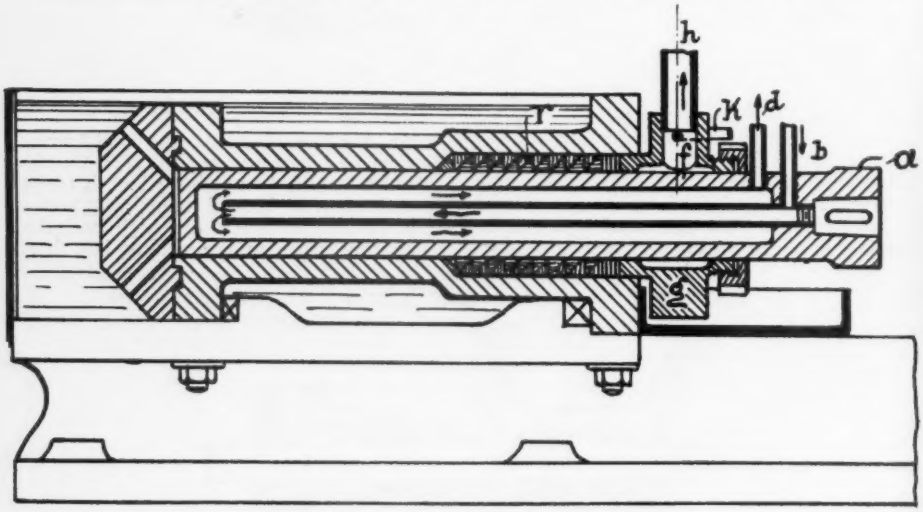


FIGURE 13.

tion in CO_2 factories. In such cases the leak gas enters the stuffing-box gas chamber at no pressure and is led back to a gasometer, which latter furnishes the gas to the compressor.

Other single-acting compressors used for refrigerating purposes soon followed. These machines receive the gas returning from the evaporating system at pressures of from 20 to 30 atmospheres. The gas returning at such pressure still contained a degree of cold as low as 0 degrees to 20 degrees Fahrenheit, and at such temperatures the inside cooling of the plunger appeared superfluous and in consequence thereof the plunger changed into a regular piston with rod. The stuffing box was provided with a lantern and lubrication by means of a continuously operating lubricating pump became a regular feature.

Various packing material was subjected to exhaustive trials with the result that simple hydraulic leather cups proved to be the most suitable for the purpose and have since been accepted by all the leading manufacturers of CO_2 machinery. These cups are made of the very best centre stock of oak-tanned leather; they withstand temperatures of 180 degrees Fahrenheit successfully, especially when saturated with lubricating oils, and form an inexpensive material of excellent wearing qualities.

Stuffing Box on Double-Acting CO_2 Compressors.

The above improvements developed the single-acting CO_2 compressor gradually, and it became a very successful machine in a comparatively short time. As soon as this was accomplished the many advantages of the double-acting compressor, particularly the greatly reduced cost of manufacture, induced the constructors to improve the stuffing box in order that a double-acting CO_2 compressor could be used without loss of gas.

A simple lantern (see Fig. 14) kept under lubrication by means of a force pump proved insufficient. The leak gas accumulated in the lantern, increased in pressure and forced the lubricating material to recede gradually. As soon as the lubricating material had been forced back below the upper line of the piston rod the gas made its way through the remainder of the packing rings until it finally escaped at the outer end.

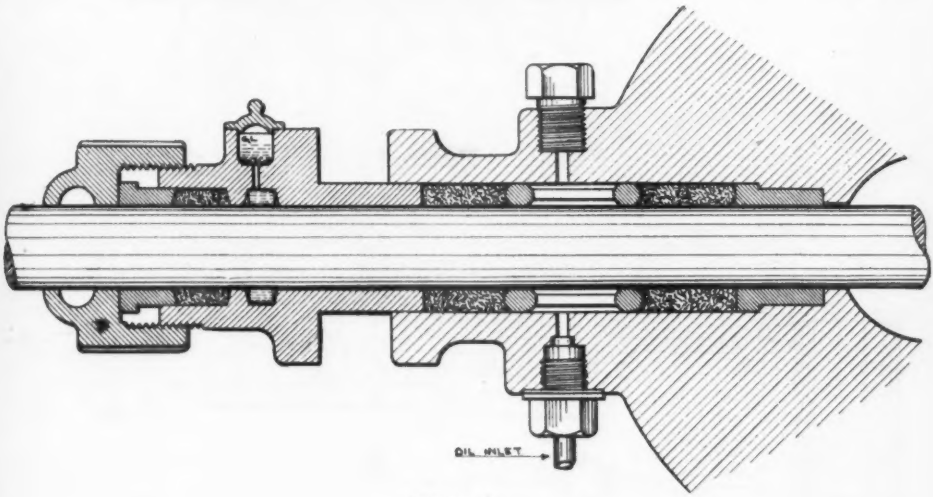


FIGURE 14.

Carbonic acid is not easily detected by its smell unless made odoriferous. A slight escape of gas through the stuffing box is sufficient, however, to extinguish the flame of a match immediately, and by making this test the engineer can readily ascertain the condition of the stuffing box. Experience taught that it was necessary to

prevent the gas from entering the stuffing box, or if that was impossible, to construct means by which the leak gas could be gathered and returned to the system.

THE J. AND E. HALL COMPANY'S SYSTEM.

Constructors of the J. and E. Hall Company, London, England, conceived the idea of lubricating the stuffing box at a pressure superior to the highest compression pressure. They reasoned that so long as the stuffing box was sealed with lubricating material at a pressure higher than the compression pressure, it was naturally impossible for the gas to escape through such a high-pressure seal. The device used is illustrated in Figure 15. A small auxiliary cylinder, *a*, is provided with a piston, *b*. The piston rod of the latter extends through a suitable cover. Piston rod chamber *C* of the cylinder contains the lubricating material, and a pipe connection with valve *d* provides the communication between the chamber *C* and the lantern in the stuffing box. Space *E* of the cylinder is connected with the condenser by means of connection and valve *f*. A hand pump forces the oil into chamber *C* at *h*, and the piston rod indicates whether same is empty or filled. After filling, valve *d* is slightly opened and the condenser pressure acting upon the full area of the piston forces the oil into the stuffing-box lantern. It is clear that the oil is subjected to a pressure which is correspondingly higher than the condenser pressure in the same proportion as the area minus the piston rod is smaller than the full area of the piston. For instance we will assume a diameter of the piston of $1\frac{3}{8}'' = 1.48$ area, a piston rod of $5\text{-}16'' = 0.07$ area and a condenser pressure of 70 atm., then the oil will be subjected to a pressure of 73.5 atm., be-

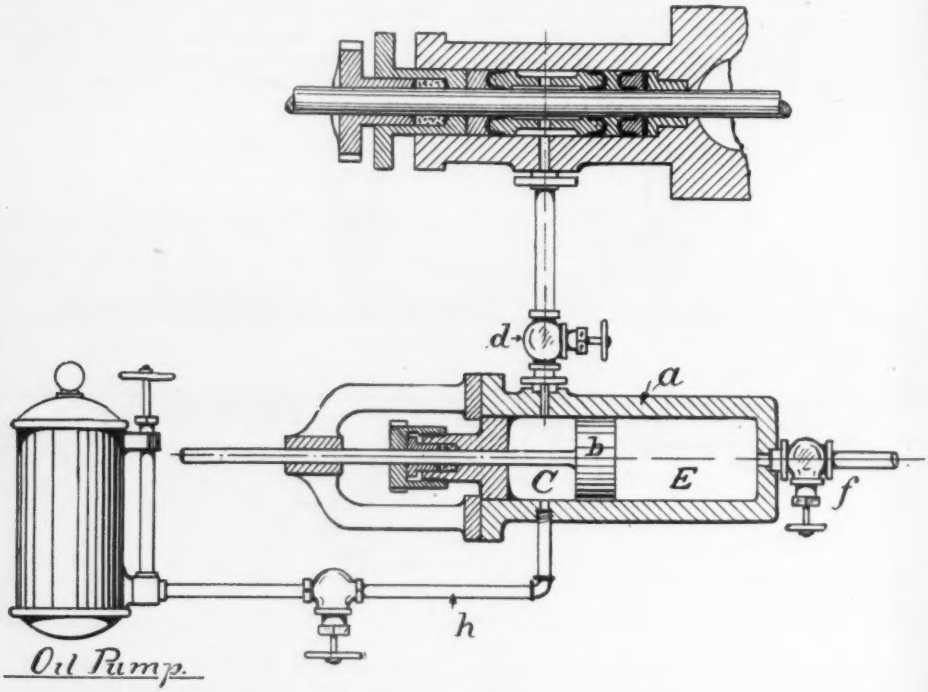


FIGURE 15.

cause 1.48:70 atm. = 1.48 — 0.07 = x, consequently

$$x = \frac{1.48 \times 70}{1.48 - 0.07} = 73.5 \text{ atm.},$$

so that the over-pressure of oil in the lantern amounts to about 3.5 atm. in this case. In spite of this example, which seems to bear out the correctness of the "Hall" theory, it has been found that this device has not eliminated the losses of gas through the stuffing box and that the oil consumption in connection therewith is excessive.

The writer is of the opinion that any attempt to prevent gas leakage by creating within the stuffing box a still higher pressure, using same as a means of checking the loss of gas, is an effort in the wrong direction. The pressure in the stuffing box should not be increased, on the contrary, it must be reduced in order to lead to good results.

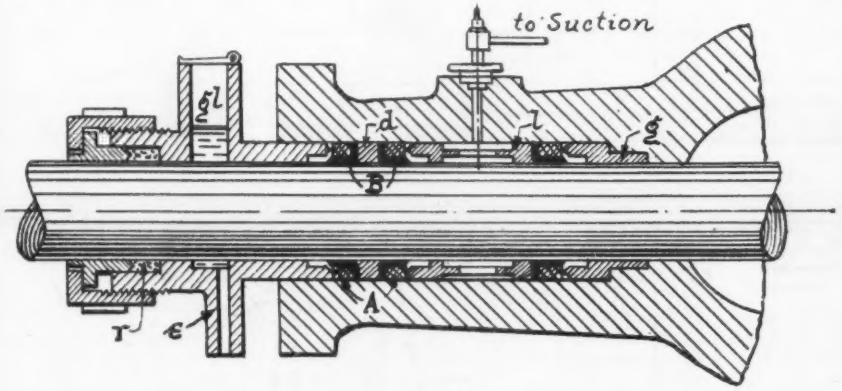


FIGURE 16.

The Riedinger System.

The firm of L. A. Riedinger, Augsburg, Germany, has accomplished satisfactory results by adhering rather closely to the "Linde" principle. This firm uses leather cups, which are held under tension by means of rubber rings. Glycerine is used as the lubricating medium to keep the leathers soft and elastic. This lubricant is preferred by them because it does not combine with the CO_2, and therefore no soaping of the pipe system occurs. Figure 16 shows the "Riedinger" stuffing box in detail. *B* represents the cupped leathers and *A* marks the rubber rings, which serve to produce the necessary tension of the cups on the piston rod. All such metallic parts of the stuffing box as are in wearing contact with the rod are made of bronze. These parts constitute bottom bushing *g*, lantern *l* and centre ring *d*. Gland *e* slips over the rod loosely and is provided with a glycerine chamber sufficiently large to contain one-half pint of glycerine. The gas chamber of lantern *l* is connected to the suction side and is therefore always under the respective suction pressure. The danger of carrying liquid into the lantern does not exist in the case of CO_2 machines, because the boiling point of the gas is so low that the temperature is never sufficiently reduced to produce that condition in any case of practical operation. The piston rod carries a small part of the glycerine into lantern *l*, and into the cylinder as well, so that all parts receive ample lubrication. A number of soft packing rings, *r*, prevent the waste of lubricating material at the outer end of the stuffing box. Gland *e* must not be drawn up too tightly, because it presses directly upon the rubber rings and these rings have a tendency to swell considerably any way as soon as they are saturated with carbonic acid. Care must also be exercised to take up on the gland equally, so as to keep it centrical, for a cocked gland will produce a great deal of friction and is sure to cut the rod. To prove the condition of this stuffing box

uncover glycerine chamber, *gl*, of the gland; a leaky stuffing box allows the gas to escape with considerable force through the glycerine, while only small bubbles will appear from time to time so long as the packing remains in good condition.

Sedlacek's Stuffing Box.

Although the results obtained with this stuffing box could be pronounced satisfactory, they were not of an ideal character and still left something to be desired. J. Sedlacek hit the nail on the head by dividing his stuffing box into several chambers, and by decreasing the pressure from chamber to chamber, so that each set of packing was subjected to a differential pressure only. Figure 17 shows the "Sedlacek" stuffing box in detail. Chamber *G* collects the leak gas until a pressure about 20 per cent. lower than the compression pressure is reached. A canal, *n*, connects chamber *G* with the suction side of the compressor. Interposed in this canal is a V-shaped valve, *v*, which is so proportioned that a suction pressure of 22 atm. on the large area corresponds to a pressure of 45 atm. on the small area.

For example, let us assume that the required high pressure averages 60 atm. In that case the gas should be released from chamber *G* at a pressure of 45 atm., so that the packing separating the compression cylinder from chamber *G* is subjected to the difference between 60 atm. on one side and 45 atm. on the other side only, which is 15 atm. The normal evaporating pressure is 22 atm., and it is then easy to proportion valve *v*, so as to cause it to release 45 atm. on its small against 22 atm. on its larger area. Oil chamber *F* is supplied with lubrication by means of a force pump, and the pressure maintained in same should always be above the suction pressure. We will fix this pressure at 30 atm. in this case and it will then be seen that the pressure is again dropped from 45 atm. at chamber *G* to 30 atm. at chamber *F*, so that the interspersed packing is again subjected only to a pressure of 15 atm. The outer packing *I* consists of "Garlock" rings, which prevent the leak-

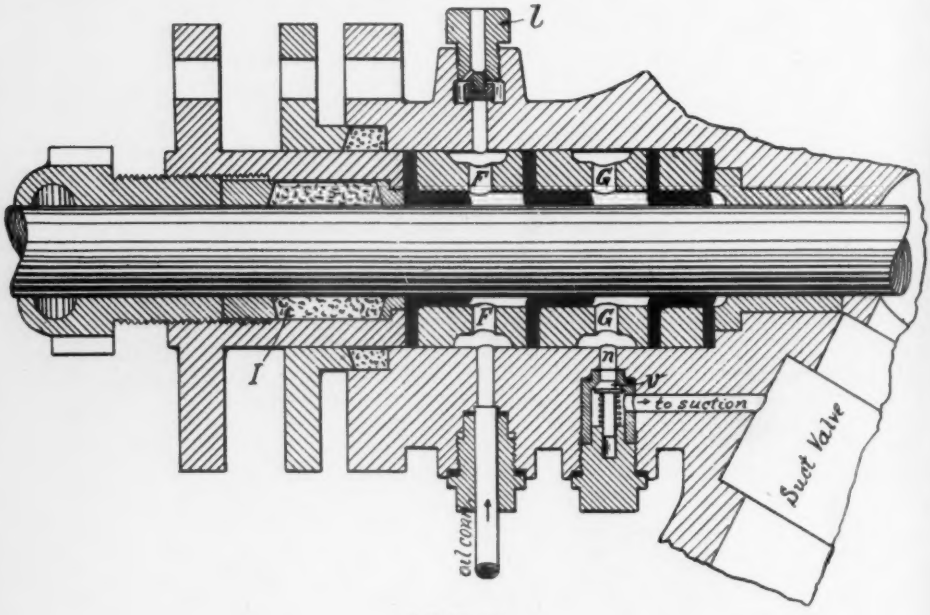


FIGURE 17.

age of lubricating material at the outer end. This stuffing box shows in operation only an occasional drop of oil and hardly ever any leakage of gas. Glycerine, which used to be the lubricating material for this stuffing box, has been discarded and ordinary low temperature ice machine oil has been substituted with success.

The Kroeschell Bros. Ice Machine Company is using the above stuffing box with uniform satisfaction. Several modifications have been found advantageous; for instance, the packing has been grouped in a somewhat different way, and in order to prevent any accumulation of gas in the upper part of chamber *F*, below plug *l*, the oil is being returned with an occasional bubble of gas to the suction side of the system, thus preventing the accumulation of gas in the outer oil chamber altogether. The oil return pipe is provided with a ball valve, by means of which an oil pressure slightly above the suction pressure is maintained. This stuffing box has solved the question of high-pressure double-acting compressors completely. The packing is durable and lasts in most cases a season or longer. The oil consumption is very small, friction is reduced to a minimum and the escape of gas is entirely prevented.

Preservation of Timber.

The use of compressed air in a new timber preservation process, known as the Rueping, is mentioned in an article on that subject which recently appeared in the *Engineering News*. The Rueping process is a German invention, the principal object of which is to make commercially practicable the treatment of timber with preservative materials which are of the highest efficiency but which have only been used to a limited extent on account of their high price.

The plant consists of impregnating cylinders strong enough to carry pressures of 100 to 225 pounds, a tar-oil or creosote tank for pressures of 75 to 120 pounds, an air compressor which may also serve as a vacuum pump, a steam pump, and a boiler. The different stages of the process are described as follows in a pamphlet issued by C. Lembcke & Co., 128 Water St., New York, who are the representatives of Huelsberg & Co., of Charlottenburg, Germany, the owners of the patents taken out by Mr. Rueping:

In the new Rueping process the seasoned wood is subjected for about half an hour to one hour to an air pressure of 60 to 65 pounds, so that all cells must be filled with compressed air. This is the principal difference between the old and the new method; with the former the air is removed from the wood cells by a vacuum, whereas with the latter the wood is filled with compressed air.

Without reducing the pressure in the impregnating cylinder, the warmed impregnating fluid is then forced from the tar reservoir into the impregnating cylinder by means of a somewhat higher pressure, say of about 65 to 75 pounds. In proportion to the quantity of tar entering the impregnating cylinder, air is permitted to escape through a valve, in order to make room for an equivalent volume of impregnating fluid. At the same time it must be borne in mind to allow only such a quantity of air to escape as cannot impair the maintenance of the pressure of 60 to 65 pounds. When the wood in the cylinder is completely covered with the impregnating fluid the pressure, according to the dimensions and qualities of the material, is to be increased to 105 to 225 pounds. Under this increased pressure the impregnating fluid will penetrate into the cells of the wood.

It might appear that through the forcible advance of the fluid the compressed air contained in the wood would be forced to the interior and there form a kind of cushion or piston which would render an impregnation of this sort impossible. But, owing to the high pressure, the tar-oil, in consequence of the capillary action of wood and its adhesive properties, moves along the cell walls into the innermost parts of the wood, soaking them entirely, by which the compressed air contained in the cells will be still more compressed and at the same time entirely kept in suspension and inclosed by the advancing tar-oil.

When the material is sufficiently impregnated the pressure with great energy, through its expansion, will force as much of the impregnating fluid out of the wood as does not adhere to the cell walls, and this surplus is thus made to flow back into the creosote tank. This is the distinctive feature of the Rueping process.

Accordingly, no more fluid can remain in the wood than is necessary for impregnating, coating or saturating the cell walls, etc., and this is the only important object

in view for the preservation of wood. In each case the pressure can be regulated in such a way that only a minimum quantity of fluid (or larger quantities, as required) remain in the cells of the impregnated wood. The oozing of the superfluous tar-oil may be increased and accelerated by exposing the impregnated wood to a vacuum for some time. By this means a further quantity of from 5 to 10 per cent. of the impregnating fluid left in the wood may be regained.

Notes on Oil Burners Using Compressed Air.*

Oil burners may be divided into three groups, according to the medium used in conjunction with the oil, to atomize or subdivide it, so that combustion may take place easily and completely, and at the same time to furnish the necessary oxygen for combustion:

First—Those using steam.

Second—Those using air at a few ounces pressure from a blower or centrifugal fan.

Third—Those using compressed air at a pressure from a few pounds to 80 or 100 pounds.

A fourth class might be made to include burners in which a combination of low and high pressure air and steam is used.

The first and third classes have each its field of special application; thus, for generating steam under stationary, marine or locomotive boilers, steam burners have almost universal application, since the ready supply of steam at hand renders it undesirable to install compressors for the purpose of air supply.

It is claimed, however, and apparently with reason, that the steam burner carries a large amount of moisture into the furnace, which renders it unfit for heating steel and iron, on account of the oxidizing and scale-forming effect of this moisture. It is in this field that the compressed air burner would seem to occupy the same position that burners using steam have in the line of steam generation. By proper regulation of oil and air, a reducing flame may be maintained and a charge of steel held in the furnace for long periods without excessive oxidation.

The low-pressure air burner has not, perhaps, been put to as extended use as the two above mentioned types, though it may be developed and more largely applied in the future. In comparison with the high-pressure burner, the cost of the atomizing medium is much less, but this point in its favor is neutralized somewhat by the imperfect atomizing of the oil, which drips to the brickwork of furnace, where it is burned to poor advantage; by difficulty in regulating when burning a small amount of oil and by the large size of pipes to carry the blast.

Burners combining the use of air and steam may perhaps be cheaper in operation than high-pressure air burners, but the additional pipe line required seems to have prevented their general application.

The advantages that commend the high-pressure air burner to users are: High temperatures under perfect control; ease of lighting; ease of maintaining an oxidizing or reducing flame and absence of any excess oxygen in the furnace; large quantity of oil that can be burned and consequent large amount of heat obtainable from each burner; the general application of air for pneumatic tools, making it possible to use the same for the burner supply. These points in their favor counterbalance, in the opinion of many, the increased cost of compressed air over steam or blast as the atomizing medium.

It is a usual precaution to store the oil supply in underground tanks, maintaining a pressure of air on its surface to produce a head at the burner. In types of burners in which the oil and compressed air meet in the body of the burner, this pressure should be at least equal to that of the air supply, otherwise the excess pressure may force the oil back to the tank and prevent its flow. Burners in which the air and oil are conducted to the end of the burner before mixing by separate passages do not require this precaution.

It may be stated as a general principle that, as far as the efficiency of a burner itself is concerned, one burner is as good as another, provided certain common-sense principles are observed in the design. Sufficient sized oil passages should also be allowed to provide free passage to grit and scale often found in oil, and accessibility for cleaning should clogging occur.

These remarks as to the equal value of many burners apply only to the burner proper or the appliance for mixing the air and oil and atomizing the latter, and

*By A. P. Hume in *Power*.

do not include an important factor in the value of a burner, viz., the shape and dimensions of the orifice in the furnace wall through which the jet is projected. This is a more important factor in the cost of operating than is generally recognized, as will be shown.

Each pound of oil requires, for its perfect combustion, about 15 pounds of air, which, with the usual practice of maintaining a plenum in the furnace, must all enter through the burner orifice. It is thus evident that the smallest amount of compressed air is used when the orifice in the furnace is properly proportioned to induce the greatest amount of atmospheric air. Since only a comparatively small quantity of compressed air is required to actually atomize the oil, as much as two-thirds of the total air required for combustion may be induced from the outside; the amount of compressed air used being thus reduced, the cost of operating the burner is less.

This principle of inducing a large amount of air has necessarily to be observed with burners using steam, but in the case of those using compressed air is often overlooked.

The usual size of burner with 20 pounds pressure on the air and oil has a consumption of oil varying from one or less to nine or ten gallons per hour, depending upon its regulation; and the proper shape and size of the fitting forming the orifice in the furnace should be determined experimentally to give the maximum induction with the burner running at its average rate.

A good material for this fitting is cast iron, but it has been found that at high temperatures a scale is formed which attacks the brickwork of the furnace with which it comes in contact. A burner brick of fire-clay or other refractory material is free from this objection and seems well fitted for the purpose. An orifice becoming gradually smaller toward the furnace, like the nozzle on an injector, is very satisfactory.

A workman in charge of a furnace may learn to regulate from the appearance of the flame so as to obtain a reducing or oxidizing flame, as desired, effecting this by changing the proportions of air and oil used. Any quantity of oil per hour within the range of the burner may be consumed, so that demands for a higher or lower temperature are readily met.

The maximum quantity of oil that it is possible to burn per hour, with a given burner, depends on the oil and air pressures, so that by raising these the quantity of heat obtainable from the burner may be increased. The calculated quantity of air required to burn Pennsylvania crude oil with perfect combustion, using the commonly accepted analysis, is about 15 pounds per pound of oil, and is equivalent, at 80 degrees Fahr., to about 1,500 cubic feet of free air per gallon of oil (7.38 pounds). It may be of interest to give the proportion of this air induced, as shown in a test made by the writer on a burner of approved form, using air and oil at 20 pounds per square inch. The burner was of the type in which the oil and air mix in the body, having six 3-32 inch holes in the end for the passage of the jets of air and oil into the furnace.

Gallons of oil burned per hour	6.5
Compressed air used per minute (cubic feet free)	61.3
Air induced through orifice per minute (cubic feet free)	98.0
Total quantity of air per minute	159.3
Total theoretical quantity of air required (cubic feet free)	164.0

Of the total volume of air used for combustion 61.5 per cent. was induced from the atmosphere, and 38.5 per cent. was taken from the compressed air line, so that almost two-thirds was induced by the remaining one-third of compressed air. The average partial analysis of burned gases, as actually determined, was:

CO_2 = 13.4 per cent. by volume.
O = .2 " "
CO = 1.2 " "

and the assumed analysis of the oil:

C = 84.9 per cent. by weight.
H = 13.7 " "
O = 1.4 " "

The total quantity of air, as actually determined and as calculated, is seen to nearly agree, and the difference, if not due to unavoidable errors in measurement of the air, may be accounted for as air induced through openings in the furnace other than the orifice for the burner by the slight vacuum due to the pull of the stack.

Under conditions of fair practice the cost of compressing air to 20 pounds, assuming that its temperature has fallen to normal by the time it reaches the burner, is about 12-100 cent per 100 cubic feet of free air. Applying this figure to the compressed

air used during the above test, its cost is seen to be 4.41 cents per hour, or .68 cent for each of the 6.5 gallons of oil burned. With oil at 3 cents per gallon, it amounts to 18 per cent. of the total cost of oil and air. Had the entire amount of air for combustion been supplied as compressed air, none being induced, its cost would have been 1.77 cents for each gallon of oil burned, amounting to 37.1 per cent. of the total cost of oil and air. Thus the cost of operating an oil burner may be almost 20 per cent. greater than necessary, if proper precautions for inducing the air are neglected.

Reheating the compressed air used before it reaches the burner suggests itself as an easily applied way of still further cutting down the cost of air and commends itself on account of the ease with which use can be made of the heat of the furnace, merely by placing cast-iron pipes or air boxes in the rear of the furnace. There is no appreciable loss of heat by this method, since that abstracted is immediately returned, and its high temperature aids in the more perfect combustion of the oil.

By heating air at the normal temperature and 20 pounds pressure to about 600 degrees Fahr., its volume, and hence its capacity for atomizing oil and inducing atmospheric air, is practically doubled by the temporary abstraction of a small quantity of heat from the furnace. This reduces the cost of compressing the air used to about half of its value for unheated air, or about 9 per cent. of the total cost for air and oil, assuming that proper arrangements for inducing air are provided.

If it is intended to install a small number of oil burners in a shop in which air at 80 pounds or more is used, the rational course is to employ this air for operating the burners. If, however, a large number of burners are to be used, it is more economical to install a low-pressure compressor for the purpose, compressing, say, to 20 pounds, for in any case the 80 pounds of air must be throttled to a few pounds at the burner, so that the work of compressing beyond this pressure is a dead loss, and not only is nothing gained in the throttling, as in the case of steam, but the lowering of temperature due to expansion is a positive loss. It requires just about twice the power to compress a cubic foot of air to 80 pounds that it does to compress the same quantity to 20 pounds pressure, so that the air for use with oil burners, if at 80 pounds pressure, is twice as costly as if supplied from a 20-pound air line.

Compressed Air as an Auxiliary for Automobiles.*

Experience in the construction and operation of large power plants has taught the great importance of the auxiliaries, or machines which have to do with the output of energy only in a secondary way. The engineer devotes quite as much care and thought to the development of the condensers, pumps, purifiers, economizers, as to the main details of engines and boilers.

The horseless vehicle, though developing rapidly, is still crude when considered in the light of other engineering work. One great drawback seems to lie in the general inconsistencies of design. The different parts do not seem intended to work together harmoniously.

The devices for circulating jacket water, feeding fuel to carburetors and burners, and lubricating engines and transmission gearing, may be classified among the auxiliaries of an automobile. As the function of these parts is, in a way, secondary, many designers are content to assign them locations which are more convenient than advantageous. The tendency seems to be to adopt the product of some "parts manufacturer" rather than to use an article designed for the particular place in which it is to be used. This may be of advantage to the maker from an economic point of view, and often insures better satisfaction to the buyer. But the result, particularly noticeable in American machines, detracts from the general uniformity of the product, and sometimes results in unsatisfactory or erratic action of poorly adapted parts. A general unification of design and operation of these very important adjuncts, and a simplification of operation and control is much to be desired.

Many of this year's touring cars, copying the Mercedes, use some form of pressure feed carburetor. Steam cars universally use a pneumatic head for feeding their burners. Several of the multi-feed lubricators on the market depend directly on air pressure for their action. The "air-line" control of one machine is too well known to need more particular mention. A car shown at the Garden in 1903 had

* By N. B. Pope in *Horseless Age*.

pneumatically operated clutches, and at least one machine of this year's vintage has a braking similar to the "direct air" used by many railroads.

Pressure feeds, as commonly used, obtain their supply variously from pressure tanks filled by hand pumps, from motor-driven air pumps, from the engine exhaust, and, in the case of certain lubricators, from fluid pumps forcing against a pressure head. In either case compressed air drawn from a continuous supply at constant pressure, such as could be automatically maintained in a storage tank, would be of evident advantage.

Besides the uses already mentioned, a construction for pumping tires on the road, cleaning about the motor and car, and so on, would be of advantage. Large stationary gas engines are started by air almost universally, and its use for that purpose on automobiles is heralded by the makers of a new car recently described to the public. Here are no less than seven possible uses of compressed air on a gasoline machine, not to mention the delight of a chime whistle, and five on a steam car.

Hence the idea readily presents itself of using a common supply and a distributing system for doing the auxiliary work, instead of having the usual complexity of chain or belt-driven pumps and their appurtenances. This has been done by the designers of the machine mentioned as having air brakes.

An auxiliary air system of this sort would consist of a compressor, storage tank and pipe line from which supplies could be drawn in proper amount as needed. The compressor might be driven in either of three ways—continuously from the motor, excess pressure being relieved by a safety valve; intermittently from some remaining part of the car itself, as, for instance, the rear axle; or intermittently from the motor by a clutch, and operated only when the main supply is being drawn upon. Each method would have its advantages and disadvantages. To find suitable location for the compressor would be easier than to place the tank where it would be unobtrusive. The pipe line would work itself out without much difficulty.

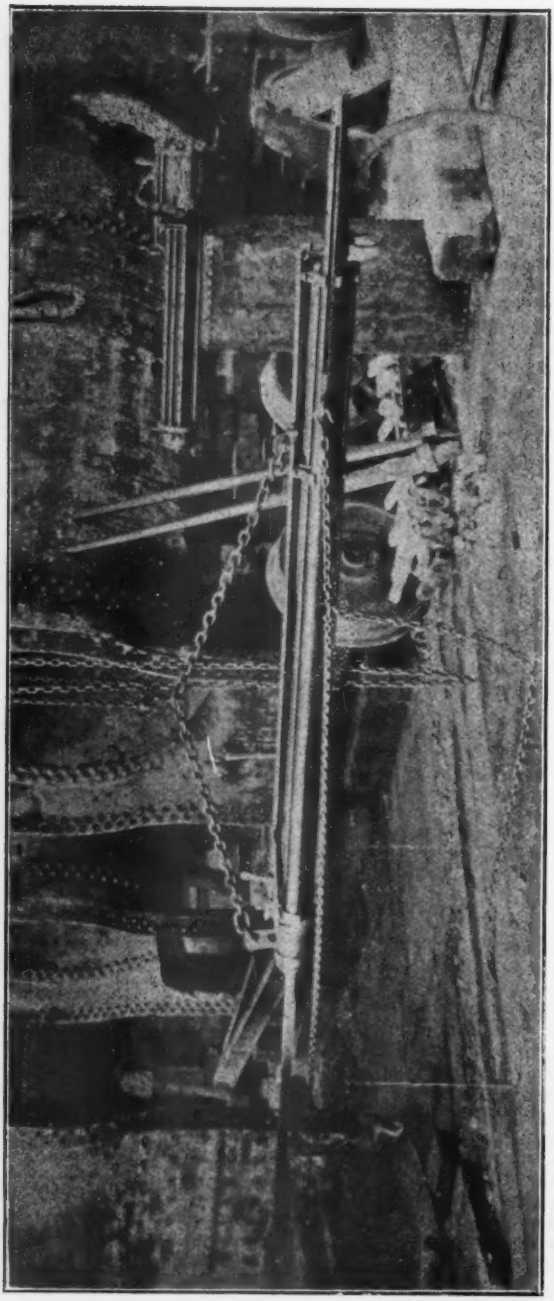
Considering the advantages of such a system, it is probable that the importance of the compressor would become so great that it would receive the particular attention of the builder, and would have, in consequence, a substantiality not usually granted parts serving the same purpose individually. The required capacity would be sufficiently great, so that cheap or flimsy construction would be out of the question. There may be a doubt as to whether or not the number of actual moving parts would be reduced, but the increased simplicity of the individual apparatus and ease of control would be marked. The advantage of continuous pressure feed over that depending on the engine speed for its intensity has been referred to. This may be qualified in the case of the lubricator, as many of the types in present use take advantage of the varying pressure to feed in proportion to the demand. But this is not a necessary feature, although it constitutes a pleasing little refinement for use as a "talking point" by agents.

To introduce such a system on runabouts or other light cars is, of course, out of the question. In fact, it would be unnecessary and superfluous for any but the heavier forms of touring car. For them, however, it would insure a better uniformity of constructive detail and more satisfactory operation. The various parts would become less independent and more cooperative than is apt to be the case at present, for the average automobile seems more like an assemblage of independent mechanisms and more or less rudely developed ideas than a machine, designed, as a whole, to perform a specific duty.

With the passage of the touring car craze will come an epoch of machines for both commercial and pleasure uses in which many of the features of the present common types will undoubtedly be retained. But these machines will be required to do their work with the unflinching regularity and certainty of operation now expected of a trolley car. What is now a desideratum in a purely pleasure vehicle will become an absolute necessity then. Roadside delays will be intolerable, and continuous smooth running essential; for the trackless car will be in competition with the railroad. The demand for better detail work in design and construction will bring about a development of the larger class of machines, in which compressed air is likely to serve an important part as an auxiliary.

Pneumatic Ram for Boiler Shops.

The accompanying illustration is a likeness of a pneumatic ram designed and made by Mr. W. H. Laughridge, master



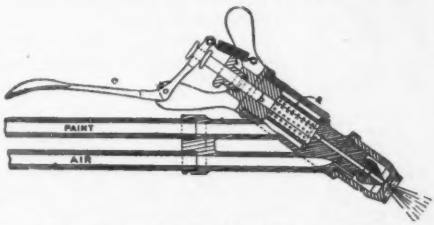
THE LAUGHRIDGE PNEUMATIC RAM—HOCKING VALLEY RAILWAY. Courtesy of *Railway Journal.*

boiler maker of the Hocking Valley at Columbus, O. It has been in use in the Hocking Valley shops for the past three months, and is one of the most successful devices of its kind we have ever seen in practical use. It is very simple in arrangement and is not difficult of construction or operation. This one is made of 4-inch pipe, being in two sections. The longer one is the ram proper in which operates a 30-pound piston which plays back and forth at the will of the operator, while the short section contains a valve and storage for air. The heads are made of forgings with recesses in to receive the pipe, and the whole are fastened together by six long ¾-inch rods.

It requires only one man to operate this machine. It is swung by a crane. One end of the chisel bar that is used to cut of the bolts, is inserted in the end of the ram opposite the air chamber, and the other end is placed against the work to be accomplished. By a simple operation of valve levers by the operator, the air is emitted into the barrel which forces the piston against the chisel bar. With one or two strokes the bolt or bolt head is cut off. To hold the ram firm, a pulley draws taut which holds the machine solid. The pulley is hooked into a convenient hole in the boiler and the chain is thrown over it and one end is fastened to the barrel on one side while the other end is hooked onto the piston of a small cylinder with a long stroke. A small lever operates the ram and another one the minor piston, which draws the chain taut. By one movement of the lever the ram becomes firm with the chisel bar against the bolt, and the other lever operates the heavy piston against the chisel bar. As the machine is swung conveniently, it is easy to transfer it from one bolt to another, as the operator accomplishes his work. Mr. Laughridge states that they can, with this machine, cut off the staybolts in a nine-foot fire box at a cost of $2.70. It can be used for cutting off rivets also. They can clip them at the rate of 300 1-inch rivets per hour, and smaller rivets at a much increased rate. It can also be used for backing out rivets, ripping plates, etc. At the right of the illustration will be seen a smaller pneumatic ram, which is used to back out rivets, punching, etc.—*Railway Journal.*

Compressed Air Painting Machine.

English engineers have been attracted of late by several new devices for painting operated by compressed air. One of the latest of these is known as the Lightning Painter, and is manufactured by A. C. Wells & Co., of London and Manchester. It is claimed that results obtained from the use of this machine have been unusually satisfactory. A sectional illustration of the spraying model is shown. A can of paint is set into a reservoir. The reservoir is filled with compressed air at from 20 to 25 pounds per square inch.



SPRAYING NOZZLE FOR THE LIGHTNING PAINTER.

This pressure will operate the machine for some time when it may be recharged. If desirable, however, it can be attached to an air line and used continuously. The air presses down on the top of the paint in the can and forces it out through the pipe which extends almost to the bottom of the paint can. The illustration shows the sprayer. The paint, after being forced up the pipe indicated in the illustration, passes from the filter plug *A* and is met at the nozzle and sprayed by the air. The supply of paint can be regulated by the valve *B* actuated by the thumb lever *C*. It is claimed that with the use of this painting machine three square yards of work can be done per minute.

Notes.

The Compressed Air Cleaning Co., of Cincinnati, O., has been formed to do a general house cleaning business.

Agitation has been started in the cities of Cleveland and Cincinnati, O., and Buffalo, N. Y., aiming toward the installation of pneumatic tube systems for the betterment of their postal service.

Systems of pneumatic tubes are to be installed in the post offices at Toronto and Montreal, Canada. The contract for these installations is said to be awarded to the Maclaren Co. of Glasgow, Scotland.

The Columbus Compressed Air Cleaning Co. has been incorporated at Columbus, O., with a capital stock of $15,000. The incorporators are U. D. Beard, Chas. G. Wolfe, John G. Dun, John Fischer and Jacob A. Pirrung.

The use of compressed air for liquid fuel burners is noticed in *The Machinery Market,* an English publication. Its use is admitted as part of the ideal system for burning oil, but the practical service of this method is questioned.

The December number of the *Railway Master Mechanic* contains a description of the new shops of the Rock Island system at East Moline, Ill. The compressed air for the shops is furnished by two Ingersoll-Sergeant Class "G" compressors, of 1,500 cubic feet capacity each.

J. Keller has been granted the English patent rights for special features of a pneumatic caulking tool. It consists of a combination of a pneumatic impact tool, a rotary caulking device, a support for the tool and device and means for detachably connecting the impact tool with the support.

The Cooper Process Company of Buffalo, N. Y., was recently incorporated with a capital stock of $25,000. Paints, oils and devices used in connection with compressed air will be handled. The directors are Henry R. Cooper, Sr., Chas. A. Criqui, Raymond W. Koerner, Geo. W. Stowe, Jr., U. S. Thomas, of Buffalo, and Herman T. Koerner, of Grand Island.

In the report of W. S. Shallenberger, the second assistant postmaster-general, to the Postmaster-General, it is noted that the pneumatic tube service is being extended wherever such service is found to be advantageous to the acceleration of the delivery of mails, extensions having been made in New York, Chicago, Philadelphia, Boston, St. Louis and other cities, Washington being contemplated in the near future.

Air-compressors to be used at high altitudes require to have the steam and air-cylinders properly proportioned to meet the varying conditions. According to Hiscox, at an altitude of 15,000 feet, where the mean barometric pressure is 8.32, the volumetric efficiency of the compressor is reduced (from 100 at sea level) to 52 per cent; the loss of capacity is 42 per cent, and the decreased power required 23.5 per cent.

—*Engineering and Mining Journal.*

A portable pneumatic duster is the latest form of suction apparatus for household cleaning. It made its first appearance in Paris. It has a bellows constructed somewhat after the fashion of an accordeon, and from it leads a tube carrying at its end a dusting brush. The bellows contains packing material which retains the dust gathered. The dusting brush is passed over the object to be cleaned in the ordinary way, and the displaced dust is drawn into the tube by operating the bellows. As soon as the dust is caught by the packing material, it cannot be discharged by compressing the bellows. When the packing is quite full of dust, it can be removed and burnt, new packing being inserted.

—*Work* (Eng.).

Messrs. Siebe, Gorman and Co., the eminent manufacturers of diving apparatus, have just turned out a diving bell which is unique. The plant was supplied to the order of the British Admiralty, and is intended to be utilized in laying moorings at Gibraltar. The vessel, which is constructed of steel throughout, is 90 feet long, with a beam of 40 feet. In the centre is a well, through which the bell proper works. This, which is of the air-lock type, weighs 50 tons, and is raised and lowered by means of wire ropes working over sheaves. Both vessel and bell are electrically lighted throughout, there being also telephonic communication between those in the bell and those in the engine-room and the air compressor room. The air is supplied by means of steam compressors and there is also a second set for working the rock drilling, machines fitted inside the bell.

—*Syren and Shipping* (Eng.).

It may be stated without much fear of contradiction that the possibilities of compressed air as "power" in the quarries

and manufacturing establishments of our granite and marble industries have developed more rapidly than the ability to make use of it in the most economical and effective manner. It is a power very easily handled and distributed, and moreover, one whose installation is within the means of any successful manufacturer or dealer. The increasing use of both steam and compressed air in the marble and granite quarries, and the improvement in the design of quarrying implements and machinery and the diversity of use for which machinery is being designed and constructed, have completely revolutionized quarrying methods and have resulted in vastly simplifying operations and in reducing the cost of the products. This, of course, means a wider use of quarry materials, to the end of securing more permanent conditions of life and living.

—*Monumental News.*

The Westinghouse Air Brake Company has recently published a valuable book of 342 pages, pocket size, entitled "Air Brake Tests." This book is one which every engineer will find useful, and it is practically invaluable to all consulting engineers who have much to do with the design of high-speed electric railways. After a short introductory chapter on the development of car braking, about eighty pages are devoted to the historic Galton-Westinghouse tests, which were conducted in England in 1878 and 1879, and which have had a greater influence on the science of braking cars than any other tests before or since. Following the record of these tests are particulars of the Paris-Lyons tests, of 1879; the Burlington brake tests, of 1886; the Westinghouse freight tests, of 1887; the Karner tests, of 1892; the Sang Hollow tests, of 1900; the Ship Road tests, of 1894; the Nashville tests, of 1895; and the recent Absecon and Atsion tests.

The album is elaborately illustrated with diagrams showing the test runs, retardation, etc., under different conditions as well as with a number of illustrations of the Westinghouse braking apparatus.

The Foundation Co., 35 Nassau St., New York, has completed the pneumatic caisson foundations for the 16-story Commercial Cable Building annex. Here the rectangular wooden caissons for the wall columns were made to form a continuous enclosure on the two street sides of the lot and were sealed together by means of steel channels and timber guards driven between the caissons. The other two sides of the lot were previously enclosed by similar caissons already existing under the walls of the adjacent buildings, thus forming a permanent cofferdam within which the water was easily drained to allow the excavation to be carried down in the open to hard-pan about 45 feet below the curb, where the piers for the interior columns are seated. Work is progressing on the reconstruction of the foundations of the pier of the Cleveland, Cincinnati, Chicago & St. Louis bridge over the Wabash River at Terre Haute, Ind. This work involves sinking two and probably three wooden pneumatic caissons and the temporary support of the superstructure on timber towers and cribs. It has recently completed the granite pivot pier for the Fordham Heights city bridge across the Harlem river at 207th street, New York. The masonry is 50 feet in diameter and is seated on an octagonal wooden pneumatic caisson sunk 90 feet below high water.—*Engineering Record.*

C. D. Abel, of London, England, has secured the English patents for an invention which will be of interest to users of rock excavation machinery. The object of this invention is to provide means for preventing an undue rise of temperature in rock-drilling machines. The invention consists in surrounding the casing of the machine with a mantle or jacket of porous material that can be impregnated with water during the operation of the machine. The machine is surrounded by a cylindrical casing the ends of which are closed by covers which are held together by rods. The machine is supported on a standard, to which it is fastened by the clamp in any required position. The whole circumference of the casing is left free. In this respect the present construction differs from the construction hitherto in use, the object being to provide room for a jacket or mantle, made of felt or any other suitable porous material, which tightly surrounds the casing. For this purpose the end covers are made to slightly overlap the ends of the casing, and the tie-rods serve as guides for the slide, that is rigidly fixed to the clamp, and co-operates in the usual way with the feed spindle.

During the operation of the machine the jacket or mantle is constantly soaked with water, either by pouring water over it by hand at suitable intervals, or by arranging a continuous stream of water to pass over it, such stream of water being of sufficient quantity to replace the water evaporated by the heat generated in the machine.

A striking example of the enlistment of science in municipal affairs was afforded recently by a statement issued by Dr. John McGaw Woodbury, commissioner of street cleaning of New York. Among other things Dr. Woodbury compared the old method of sprinkling streets with watering carts and the new method of flushing the street and proved by means of photographs that the new method almost entirely rids the streets of bacilli:

"There is but one way to sanitarily cleanse asphalt pavement, and that is by thoroughly washing the surface with water. I mean by washing the surface applying the water to the asphalt with a sufficient degree of force to thoroughly scour all the loosened gum which so tightly clings to the asphalt. The proper condition to keep a street in is not wetted down so as to prevent the blowing of dust, but so cleaned from proper washing that there is no dust. With thorough washing with compressed air machines or with hose from the hydrants, this can be done. During the past year Fifth avenue from Fifty-ninth street to the Washington arch, Broadway from Forty-second street to Fourteenth street, and other streets have been washed every night, beginning at about 1 o'clock and ending about 4. The results have been very satisfactory, as is shown by the photographic conditions existing in the air six inches above the curb level at various stations on these streets. Upon the east side of this city, the department of street cleaning has washed every street certainly once a week, and the more densely crowded thoroughfares every day. This makes an average daily washing of 60 miles of street area in this district. I would respectfully call attention to the low death rate which we have at present in this properly washed and cleaned district."

—*Public Opinion.*

An English patent relating to power hammers has been secured by Peter Pilkington, Limited, and G. J. Gibbs, Bamber Bridge, near Preston. This invention relates to power hammers in which the hammer-head or tup is caused to reciprocate by the alternate compression and exhaustion of a fluid in the hammer-chamber, or by putting the hammer-chamber alternately into communication with a source of pressure and an exhaust receiver. The source of pressure is generally an enclosed space charged with compressed air by means of an air-compressing pump, and the exhaust-receiver is generally an enclosed space from which air has been drawn by a pump. The main object of the invention is to relieve the pumps of unnecessary work in compressing or exhausting the air. This is accomplished by providing a port or passage in the hammer-chamber controlled by a valve; this port is normally kept closed by the valve. When, however, it is required to get rid of the compressed air in the hammer-chamber and quickly obtain the necessary rarefaction to effect the return stroke, this port is momentarily opened, thus putting the hammer-chamber into communication with the atmosphere, and reducing the air pressure in the hammer-chamber to that of the atmosphere before opening the hammer-chamber to the exhaust receiver. By this means the amount of air which the exhausting pump has to withdraw is reduced, and a corresponding economy of power achieved. A similar operation can be repeated after the air has been exhausted from the hammer-chamber and before air is turned into it again to effect the return stroke; that is to say, the valve is momentarily opened, so as to admit air into the hammer-chamber, and restore the pressure therein to that of the atmosphere. By this means the amount of air the compressing pump has to deal with is reduced, and a corresponding economy of power effected. The port may be provided with a non-return valve, allowing air to pass in one direction only.

Visitors at the St. Louis Fair will no doubt recall the display of the A. S. Cameron Steam Pump Works, of East 23d street, New York, in Machinery Hall, as shown in the illustration. This exhibit was awarded the gold medal.

A number of Cameron pumps were also placed in actual service by the Exposition, forming a working exhibit. The various styles and sizes of working pumps exhibited met all requirements in mines,

quarries, collieries, railroads, rolling mills, plantation irrigations and general pump service. The sectional model also on exhibition was arranged with the steam end and water valve chest open to view, showing the inside mechanism, and the accessibility of the various parts.

The Cameron pump has no outside valve gear or moving parts. The steam valve works in line with the piston without the intervention of arms or levers, enabling the pump to run without danger at a great speed, and without liability of injury

CAMERON EXHIBIT AT ST. LOUIS EXPOSITION.

should the suction pipe be lifted out of the water. There being no dead centre they start at any point of the stroke.

Besides a number of regular patterns on exhibition there was a Cameron fuel oil pump and heater for use in connection with an oil burning system; the distinctive features being the by-pass valves and piping, to avoid, when desired, pumping oil through the heater. This is important as exhaust steam may be utilized to heat the oil to any degree necessary by using the by-pass in connection with it. There were also an oil line pump, for handling crude oil or a fine petroleum, a vertical boiler feed pump, a vertical deep well engine, several contractors' differential pumps and vertical plunger and piston sinking pumps for mine service. Another type shown was a large pot valve pump, designed and to be adapted to mine station pumping and heavy service. This is of a very modern type and is especially noted for use in mines which are subject to floods from surface drainages or workings, or cutting into subterranean bodies of water, which necessarily must be pumped out in short order; also where the water is strongly impregnated with sulphur and the use of the ordinary iron pump prohibited.

Considerable interest has been shown in railroad circles regarding an experimental locomotive, now under construction for the Southern Pacific Railroad, which proposes to combine fuel oil power, compressed air and electricity. It is an application of the Diesel type of engine locomotion. The engine proper is being built at the Corliss works in Providence, R. I. The generator and electrical parts

will be built by the General Electric Company at Schenectady, and the trucks and frame by the American Locomotive Company at Schenectady. Every part of the new locomotive is of standard make.

This new locomotive is the design and joint product of Joseph H. Hoadley, president of the International Power Company, and organizer of the American Locomotive Company, and Walter H. Knight, chief engineer of the International Power Company, and formerly with the General Electric Company. It embraces some remarkable features. The Diesel engine, which heretofore has been applied to stationary engine work alone, will be used to drive a dynamo which will provide the electric power for the locomotive. A speed of from 100 to 120 miles an hour is expected on the trial run. There is said to be no limit within reason for the speed the locomotive might attain, provided the roadbed and other conditions permitted.

Four duplex Diesel engines will furnish the power for the dynamos that generate the electricity on the locomotive.

Its action is on what is known as the four-stroke cycle. There is a compressed air reservoir from which the power is obtained for starting. This gives the piston its first stroke when it takes in air —air alone at atmospheric pressure and temperature. The second stroke compresses this air to a high pressure and to a temperature of about 1,000 degrees Fahrenheit. The third stroke is what is known as the working stroke. At this point oil is sprayed into this hot, incandescent air. The amount of oil that is sprayed in is regulated by governors. During the first part of this stroke the combustion of this oil is carried on at a constant pressure for a period which is regulated by the amount of oil sprayed in. The second part of the stroke is practically an expansion without transference of heat. The fourth stroke exhausts the gases.

The only fuel used is the crude oil that costs from 3 to 5 cents a gallon. Petroleum or any kind of crude oil can be employed. The cost per horse power is said to be less than half that for steam.

In describing the new shop and car house of the Public Service Corporation of New Jersey, in its issue of December 10, the *Street Railway Journal* describes the compressor equipment as follows:

"In the machine shop adjacent, which is about 30 feet by 72 feet in size, ample room is provided for the machine tool equipment and the benches for all classes of bench work, and it also includes the air compressor outfit which was recently installed to supply the high-pressure storage air for the storage air-brake system used upon the lines of this company. The latter equipment, which, as above mentioned, was described in the June 25 issue of this journal, is of more than usual interest on account of the supersession of the individual motor-driven air compressor upon each car by storage tanks in which a large quantity of compressed air is stored under very high pressure, and fed to the brake system through a reducing valve. An accompanying photograph illustrates the equipment of compressors and storage tanks in the machine shop at the Montclair car house. Each of these compressors can compress 100 cubic feet of free air per minute. They are of the two-stage type, with cylinders in tandem, each of which is provided with water-cooling jackets of the usual type; each is driven by a Westinghouse type 56 railway motor, provided with special armature shaft, with driving pulleys upon each end, and two belts are used to drive each compressor, one running to either fly-wheel. The compressors operate at 100 revolutions per minute and deliver at a pressure of 325 pounds per square inch. The motors are controlled by the standard K-10 type of controllers, which are individually mounted near the motors, as shown. The air compressors, as well as also the brake equipments upon the cars, were supplied by the National Electric Company, of Milwaukee, Wis.

"The station storage tanks, three in number, are located at the rear of the compressors and set in a pit in the floor. The air passes from the high-pressure delivery of the compressors to the first tank, which is provided with a safety valve; from that tank it passes to the middle tank, and thence to the third, from which delivery is made to the street car hose delivery boxes for the cars. The air in thus passing serially through the three tanks, is thus afforded the maximum opportunity to cool before entering the car storage tanks. The station tanks are of heavy construction, 36 inches in diameter and 18 feet high; the three have a total capacity of 382 cubic feet, their combined capacity at the pressure of 325 pounds

being 8434 cubic feet of free air. They are made of ½-inch steel plate, with convex heads of 9-16 inch thickness; their longitudinal seams are of the double-butt strap triple-riveted type, while the circumferential seams are double riveted for extra strength, the test pressure having been 600 pounds hydraulic pressure before acceptance. They were built by the Niles Boiler Works, of Niles, Ohio.

"A brief reference to the car air equipment may also be of interest in this connection. Each car is equipped with two storage reservoirs 18 inches by 78 inches in size, one beneath each side, for the high-pressure air storage. These are provided with connections ending in a solid head coupling of the usual air-brake hose type, from which they are filled at the car house air supply boxes. From these tanks air is fed through a reducing valve into a service reservoir, 12 inches by 42 inches in size, from which the supply is taken through the motorman's valve in the usual manner for the brake system, which is of the Christensen "straight air" type. The reducing vale in the supply to the service reservoir reduces the pressure therein to 50 pounds, thus providing a very large storage capacity. Two gauges are provided in each car vestibule, one of the double type to show both the storage tank pressure and the service reservoir pressure; the other gauge is connected to the train pipe to show the pressure acting in the brake cylinder. The brake cylinders are of the double piston type of the National Electric Company, and are 8 inches in diameter; the entire car equipment, including the motorman's valves, brake equipments, etc., were supplied and are being installed by the National Electric Company."

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz.: all communications should be written on one side of the paper only; they should be short and to the point.

Boston, Mass., Dec. 5, 1904.

To the Editor of COMPRESSED AIR:

The present form of compresed air meters, both the French and the American make, are decidedly unreliable, their variations being 15 per cent. to 20 per cent. of the truth.

In the writer's opinion, the only form of practical meter of this nature for large quantities of air would be one constructed on the basis of the Venturi meter; or for small quantities, a floating valve like that made by Mason Regulator Co. with a recording device similar to that shown on page 751, volume 14, Transactions of A. S. M. E., by Frank Seler Mannheim.

Very truly yours,

William O. Webber.

INDEX.

	PAGE		PAGE
Centralization of Fower Plants.....	3286	Modern Quarry Plant in Mexico....	3289
Compressed Air as an Auxiliary for Automobiles	3317	Notes	3320
Compressed Air in Mine Operation.	3297	Notes on Oil Burners Using Compressed Air	3315
Compressed Air Painting Machine..	3320	Pneumatic Ram for Boiler Shops...	3318
Compressor Stuffing Box.....	3304	Preservation of Timber.....	3314
Logging Operations by Compressed Air and Steam.....	3297	Prizes for Advertisements.....	3288

U.S. PATENTS GRANTED NOV., 1904.

Specially prepared for COMPRESSED AIR.

773,588. PNEUMATIC TIRE. Charles H. Pierce, Alma, Cal. Filed June 3, 1903. Serial No. 159,968.

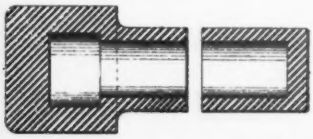
773,663. SAND-BLAST APPARATUS. Jeremiah E. Mathewson, Broadheath, England. Filed Dec. 9, 1903. Serial No. 184,409.

A sand-blast apparatus for cleaning castings the combination with a sand-blast machine and a chamber in which the castings are cleaned, having collecting-hoppers and a suction-pipe, of a cyclone-separator for separating the air and the finer dust from the cutting-sand and an air-sieving device arranged to receive the residual sand from said separator and to complete the separation of the cutting-sand from the unusable fine sand and dust, as set forth.

773,665. SAND-BLAST APPARATUS. John D. Murray, San Francisco, Cal., assignor, by mesne assignments, to Marine Construction Co., a Corporation of California. Filed Oct. 29, 1903. Serial No. 179,080.

A sand-blast apparatus, a receiver and means to maintain air-pressure therein, a sand-hopper inclosed in said receiver, with means to admit air-pressure to the said hopper, a sand-valve in the bottom of said hopper, with means for operating said valve from outside the receiver, and a sand-ejector in said receiver beneath said hopper, communicating with the latter by means of said valve, substantially as specified.

773,770. SET FOR PNEUMATIC RIVETERS. Wilber H. Van Sickel, New York, N. Y., assignor to Thos. H. Dallett Co., Philadelphia, Pa., a Corporation of New Jersey. Filed Oct. 2, 1903. Serial No. 175,475.



A set formed of two parts integrally united together in which the part adjacent to the striking end is hollow.

773,796. VALVE FOR COMPRESSED-AIR WATER-ELEVATORS. John L. Latta and James A. Martin, Hickory, N. C. Filed June 26, 1903. Serial No. 163,277.

In combination, a valve-casing having supply, delivery and exhaust ports, a slide-valve controlling the ports, a pair of axially-alined cylinders in communication with the interior of the casing, pistons arranged in said cylinders, a valve-stem connecting the pistons to the valve, a cylindrical valve-chamber, an oscillatory primary valve disposed therein, pressure-ports leading to the chamber, a pair of cylinder-ports leading from the chamber to the two cylinders, a pair of exhaust-ports also leading from said chamber, and two sets of controlling-ports formed in the primary valve, each set comprising a radial port for communication with the pressure-port, a pair of angularly disposed radial ports for alternate communication with the cylinder ports, a radial port for communication with the exhaust-port, an axial passage formed in the valve and uniting all the ports of each set to each other, and means for oscillating said cylindrical valve.

773,851. PNEUMATIC PIANO-PLAYER. Frank V. Crofut, Derby, Conn., assignor to The Sterling Co., Derby, Conn., a Corporation. Filed Mar. 18, 1904. Serial No. 198,822.

774,054. VACUUM APPARATUS. Martin Ekenberg, Stockholm, Sweden, assignor to Martin Ekenberg's Aktiebolag, Stockholm, Sweden. Filed Oct. 30, 1902. Serial No. 129,342.

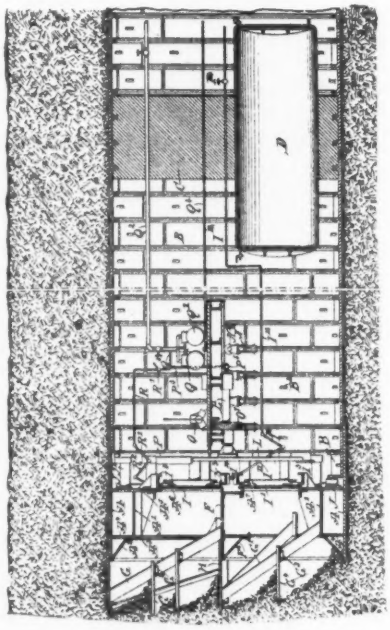
An apparatus for the purpose specified, the combination of a vessel having in it a chamber to receive a liquid under pressure for operating an injector device, a chamber to receive air charged with moisture, injector devices for removing the air from said chamber, means in the air-receiving chamber for condensing the moisture in the air, and means for expelling the liquid of condensation from said chamber.

774,088. AUTOMATIC FLUID-PIPE CONNECTION FOR RAILWAY-CARS. Dominicus R. Leighton, New Haven, Conn., assignor of one-half to Frederic L. Leighton, New Haven, Conn. Filed Feb. 27, 1904. Serial No. 195,581.

774,089. AUTOMATIC SLIDE-VALVE GAS AND AIR BLOW-PIPE FOR SOLDERING, &c. John L. Le Man, Sunbury, England. Filed Oct. 12, 1903. Serial No. 176,789.

774,157. SIMULTANEOUS VALVE DEVICE FOR AIR-BRAKES. John W. Cloud, London, England, assignor to Westinghouse Air Brake Company, Wilmerding, Pa., a Corporation of Pennsylvania. Filed Mar. 9, 1904. Serial No. 197,356.

774,546. SHIELD TUNNEL CONSTRUCTION. Walton I. Aims, New York, N. Y. Filed Feb. 29, 1904. Serial No. 195,821.



A shield for tunnel construction, provided with a hood at the forward end of the shield, as set forth.

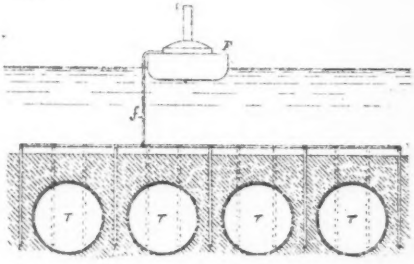
A tunnel construction, the combination with the tunnel-lining, of a shield having its tail end slidable on the lining, means for moving the shield forward, supports on the sides of the lining, an erector-platform mounted to travel on the said support and leaving unobstructed working spaces above and below the platform, and a coupling for connecting the erector-platform with the said shield, to move the platform with the shield, as set forth.

A tunnel construction, a device for placing the sections of a lining in position, provided with singly-removable bearings secured to the sides of the lining, an erector-platform mounted on the said bearings to travel lengthwise in the tunnel, a shaft mounted to turn and disposed axially on the said platform, and an erector-arm secured on the said shaft and adapted to carry a lining-section to position.

A tunnel construction, a device for placing the sections of the tunnel-lining in position, consisting of an erector-platform, a shaft journaled thereon and extending centrally in the tunnel, a motor on the platform, connected with the shaft, for driving it, an arm secured on the said shaft, a power-cylinder on the said arm, an erector-slide on the said arm and connected with the piston-rod of the piston in the said power-cylinder, a motive-agent supply for the said cylinder, extending axially through the said shaft, and a pump mounted on the said platform and having its discharge connected with the said motive-agent supply, as set forth.

774,579. PNEUMATIC TEAT-CUP. Alexander Gillies, Terang, Victoria, Australia. Filed Apr. 25, 1904. Serial No. 204,904.

774,594. METHOD OF CONSTRUCTING TUNNELS. Ernest W. Moir, London, England, assignor to S. Pearson and Son, Limited, London, England. Filed June 16, 1904. Serial No. 212,791.



The herein-described method of constructing tunnels, consisting in providing longitudinal rows of vertical freezing-pipes alongside the tunnels, and in advance thereof and also a transverse row of such pipes across the forward ends thereof, and supplying a circulating freezing medium to the pipes from a source outside the tunnels.

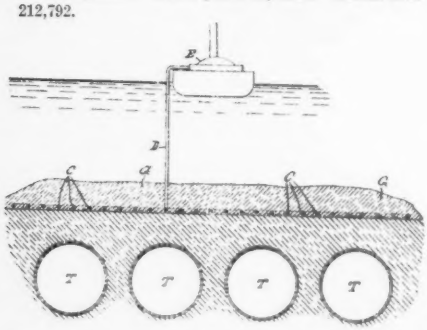
774,790. PNEUMATIC TIRE. Edward H. Seddon, Brooklands, England. Filed Nov. 24, 1903. Serial No. 182,538.

775,062. AIR-BRAKE. James C. Clyde, San Francisco, Cal. Filed Nov. 24, 1902. Serial No. 132,625.

775,141. COMPRESSED-AIR BRAKE. Georges E. Houplain, Paris, France, assignor to The Firm of Societe Generale des Freins Lipkowski, Paris, France. Filed June 14, 1904. Serial No. 212,520.

775,286. AUTOMATIC AIR-BRAKE COUPLING. Harry O. Beale, Orono, Me., assignor of one-half to William M. Ayer, Oakland, Me. Filed Apr. 7, 1904. Serial No. 201,982.

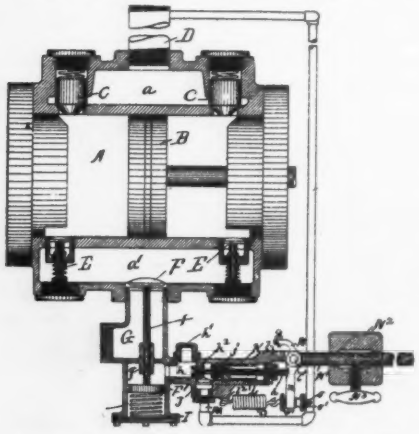
774,595. METHOD OF CONSTRUCTING TUNNELS. Ernest W. Moir, London, England, assignor to S. Pearson and Son, Limited, London, England. Filed June 16, 1904. Serial No. 212,792.



The mode herein described of constructing subaqueous tunnels, consisting in providing in the bed of the river, over the advancing ends of the tunnels, a horizontal grillage, and circulating a freezing medium through said piping from a source outside the tunnels, to form a frozen roof over the tunnels.

775,313. AIR-BRAKE-CONTROLLING APPARATUS. William J. Schlacks, Colorado Springs, Colo. Filed Oct. 24, 1903. Serial No. 178,401.

775,393. REGULATOR FOR COMPRESSORS OR THE LIKE. Rudolph Conrader, Erie, Pa. Filed Feb. 17, 1902. Serial No. 94,517.



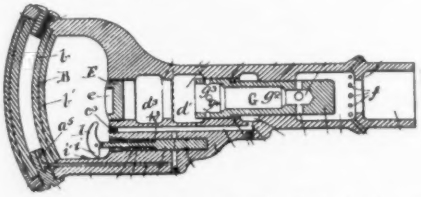
A regulating device, the combination with a compressor; of a regulating-valve arranged to operate upon the intake of the compressor; a valve-actuating motor arranged to influence the regulating-valve; means for connecting said motor with a fluid-supply, said motor being arranged to act with a change of pressure in the receiver for said compressor; and means for controlling the fluid-pressure on the motor while in communication with the fluid-supply to intensify the variations of pressure on the motor over the fluctuations of pressure in the receiver.

775,492. PNEUMATIC TIRE FOR VEHICLE-WHEELS. Adrian R. Karreman and Oreste Del Guerra, Chicago, Ill. Filed Apr. 27, 1904. Serial No. 205,268.

775,661. AIR-RELIEF VALVE. James T. Lewis, Chattanooga, Tenn. Filed July 18, 1904. Serial No. 217,095.

775,769. PIPE-JOINT FOR AIR-BRAKE CONNECTIONS. Sigmund Feust, New York, N. Y. Filed Dec. 9, 1903. Serial No. 184,509.

775,784. PNEUMATIC HAMMER. Clark J. Smith, Ottumwa, Iowa. Filed May 23, 1904. Serial No. 209,332.



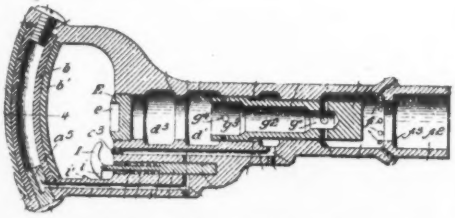
A tool of the character described, having a pair of extending arms, and a bridge member held between said arms to form a handle for said casing, said casing having bores on its interior of two different diameters, a hollow reciprocating member having an enlarged head adapted to fill the bore of greater diameter, and an elongated body portion adapted to fill the bore of lesser diameter, the head forming a shoulder in conjunction with the body portion adapted to be contacted by pressure to drive the reciprocating member in one direction, an annular air-receiving chamber at the junction of the bore of lesser diameter with the bore of greater diameter, a second annular chamber formed in the casing, of greater diameter than either of the bores, into which the head portion is adapted to be driven at the completion of a stroke in one direction, said reciprocating member having apertures in its head portion, said head-receiving annular chamber and said second annular chamber being in communication with each other when the reciprocating member is in one position, and out of communication with each other when the reciprocating member is in another position, said re-

ciprocating member being provided with discharge openings at the end opposite its head adapted to be contacted by the walls of the bore of lesser diameter when pressure is initially admitted to the interior of the reciprocating member and open for the discharge of air at the completion of its reciprocation, said casing being provided with an annular, elongated chamber into which the exhaust end of the reciprocating member is adapted to move at the completion of the reciprocation, and into which the air is discharged from the reciprocating member, said casing being provided with a thickened portion having apertures, said apertures discharging the exhaust-air at an angle to the axial line of the casing, and toward the work to be operated upon, and said casing being provided with air-supply passages leading into the air-receiving chamber, and a throttle-valve in said passage for controlling the air-supply, substantially as shown and for the purposes specified.

775,824. PNEUMATIC TIRE. Frederick R. Keith, Randolph, Mass. Filed Feb. 13, 1904. Serial No. 193,402.

775,841. CAP FOR AIR-VALVES FOR SURGICAL CUSHIONS OR THE LIKE. Christian W. Meinecke, Jersey City, N. J., assignor to Meinecke & Co., New York, N. Y., a Corporation of New Jersey. Filed Aug. 13, 1904. Serial No. 220,678.

775,863. PNEUMATIC HAMMER. Clark J. Smith, Ottumwa, Iowa. Original application filed May 23, 1904, Serial No. 209,332. Divided and this application filed Oct. 14, 1904. Serial No. 228,447.



A pneumatic tool, the combination of a frame comprising a shell or casing, having an air-inlet passage, a reciprocating member mounted within said shell or casing, arms rearwardly projecting from said shell or casing, one of said arms being provided with an air-passage communicating with said air-inlet passage, diverging heads having countersunk portions formed at the ends of said arms, screws projecting through said heads, a handle mounted between said heads and held in position by said screws, said handle members composed of elastic tubular material adapted to enter said countersunk portions of the heads, one of said screws having an air-passage adapted to register with the air-passage in the arms, all being arranged substantially as shown and described.

775,885. AIR-PUMP. George L. Bennett, Chicago, Ill. Filed Feb. 8, 1904. Serial No. 192,713.

The combination in an air-pump of the movable handle having a mortise adapted to receive a tenon, the thumb-screw in the outer end of said handle, the stud having a tenon adapted to fit in said mortise, the handle being pivoted to said stud, the stud fixed to the crown of the floating bell, the valve-tube having guide-bars provided with means for receiving a slidable valve-stem, said valve-tube fixed to the crown of bell, the outwardly-closing valve having a stem carrying a disk head adapted to engage the thumb-screw, the valve-stem provided with an actuating-spring, the bell adapted to float in the liquid-tank substantially as described.

775,949. PNEUMATIC-DESPATCH APPARATUS. Charles F. Stoddard, Boston, Mass., assignor to American Pneumatic Service Company, Dover, Del., a Corporation of Delaware. Filed Oct. 5, 1903. Serial No. 175,832.

775,975. PNEUMATIC BAG-TURNING MACHINE. Joachim Iverson, Indianapolis, Ind., assignor to Bemis Bro. Bag Co., St. Louis, Mo., a Corporation of Missouri. Filed Sept. 21, 1903. Serial No. 174,040.

775,976. METHOD OF TURNING BAGS. Joachim Iverson, Indianapolis, Ind., assignor to Bemis Bro. Bag Co., St. Louis, Mo., a Corporation of Missouri. Filed Sept. 21, 1903. Serial No. 174,041.

775,996. MACHINE FOR TURNING BAGS. Charles F. Sparks, Alton, Ill., assignor to Bemis Bro. Bag Company, St. Louis, Mo., a Corporation. Filed Oct. 18, 1902. Serial No. 127,794.

776,456. PNEUMATIC STRAW-STACKER FOR THRESHING-MACHINES. Robert Christie and Thomas B. Christie, Hamilton, Canada. Filed May 2, 1903. Serial No. 155,281.

Westinghouse
Air Compressors

Motor-Driven Air Compressor

Dust and Water-proof

For Particulars address:

Westinghouse Traction Brake Co.

26 Cortlandt St., New York

Manufactured by

The Westinghouse Air Brake Co.

Commercial Law
TAUGHT BY MAIL

No business man can afford to be without the information contained in the I. C. S. Commercial Law Course, for it will enable him to carry on business transactions more intelligently, and to avoid much trouble and litigation.

The laws of contracts, commercial paper, banks and banking, partnership, corporations, trusts, patents, copyrights and trade-marks, debtor and creditor, executors and administrators, etc., etc., are fully treated. Since the Course is especially written for self-instruction, the presentation of all the subjects is very clear and simple.

The six Bound Volumes of this Course, being virtually duplicates of the Instruction Papers, contain the complete Course in permanent form. They can be obtained with or without the privilege of instruction by mail.

Send for full particulars to-day.

International Correspondence Schools,

Box 1132, Scranton, Pa.

PRESS CLIPPINGS

Are Every Day Being Made a

Source of Great Profit
IN THE BUSINESS WORLD

They supply the manufacturer and business man with valuable information as to new markets and outlets for their products and goods. They supply anyone interested in any matter with all the information from all parts of the country, pertaining to that subject.

THE INTERNATIONAL
PRESS CLIPPING BUREAU

which is the largest Press Clipping Bureau in the world, will send you daily everything printed in every newspaper, magazine or trade journal in the country, on any particular subject

This Bureau reads and clips 55,000 papers and other periodicals each month, and can furnish anyone everything printed in the country on business, financial, political, social, theatrical, scientific, sporting, agricultural, mining, or, in fact, any subject whatever that is mentioned in the columns of any newspaper or publication. Write and state the subject you want clippings on and we will quote you a

SPECIAL BARGAIN RATE

for a trial month, that you may understand the great advantages to be derived from press clippings. Address,

International Press Clipping Bureau

909 Boyce Building, CHICAGO, U. S. A.

ANY MAN

mechanically inclined, knows the advantage and necessity of keeping himself well informed as to the progress which is being made continually in the machinery world. Our monthly journal,

MODERN MACHINERY

tells you every month all about this progress. It is well illustrated and interestingly written, and costs but $1.00 per year. Single copies 10 cents.

WE WANT

every reader of COMPRESSED AIR to send us his subscription at once, so that he may take advantage of our liberal offer.

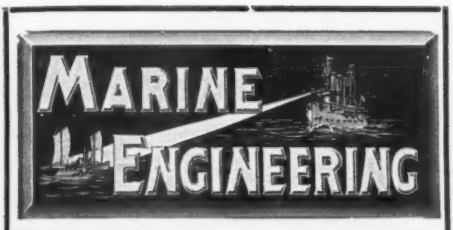
Send us $1.00, and we will send you ***Modern Machinery*** for one year, and

we will also send you, free of all charges, one of our Improved Gravity Stylo Pens, an improvement over the ordinary fountain pen.

. . . SUBSCRIBE AT ONCE . . .

Modern Machinery Pub. Co.

816 Security Building, Chicago, Ill.



The Only Publication in the World

Devoted exclusively to Engineering as applied to Marine work is Marine Engineering

TERMS OF SUBSCRIPTION

	Per Year	Per Copy
United States Canada and Mexico,	$2.00	20 cents
Other Countries in Postal Union,	2.50	25 cents

SAMPLE COPY FREE

MARINE ENGINEERING

17 Battery Place, NEW YORK, U. S. A.

The Draftsman

A MONTHLY PAPER

$1.00 per Year

4 Months' Trial 25 Cents

P. O. Box 136, Station B, Cleveland, Ohio

Compressed Air.

Practical information upon Air-Compression and the Transmission and Application of Compressed Air.

By FRANK RICHARDS. 12mo, cloth, $1.50

John Wiley & Sons, New York.

THE ENGINEER

Is a power-plant paper for engineers—for those who install, operate and care for machinery, whether steam, electric, gas or hydraulic.

The issues of one year contain about one thousand pages of reading matter. The articles are in the highest degree educational, and of the most authoritative character. Every phase of every power plant subject is treated in a manner both popular and interesting.

ISSUED TWICE A MONTH

One Dollar a Year WRITE FOR FREE SAMPLE COPY

THE ENGINEER PUBLISHING COMPANY

355 DEARBORN STREET, CHICAGO

Houghton's Non-Carbonizing Pneumatic Lubricating Oils

Houghton's Air Compressor Oil possesses the very highest efficiency as a lubricant for air compressors of pneumatic power systems.

Houghton's Pneumatic Tool Oil is a modification of the Air Compressor Oil, to better adapt it for the lubrication of pneumatic tools.

Both of these oils are guaranteed not to carbonize and leave a charred deposit; to be absolutely free from gum, dirt, grit or other foreign matter, and to possess the very highest efficiency as lubricants for their respective uses.

Fuller detail can be had from our circular, sent free of charge upon mentioning this advertisement.

E. F. HOUGHTON AND COMPANY

240-250 West Somerset Street
PHILADELPHIA

175-177 Lake Street
CHICAGO

96-110 Bates Street
DETROIT

Want to Reach the Railroads of the Entire World?

You can do so by advertising in **THE RAILROAD GAZETTE.** We publish two editions—one in New York and another in London. If you advertise in the American edition your advertisement is reprinted in the latter without extra charge.

Amongst railroad officials the circulation of the RAILROAD GAZETTE is greater than the combined circulation of all other railroad papers. It covers all departments of railroading and is a recognized authority. We publish all the standard railroad books.

Advertising rates on application.

THE RAILROAD GAZETTE 83 Fulton Street, New York.
The Monadnock, Chicago.
Queen Anne's Chambers, London.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering.

ESTABLISHED 1874.

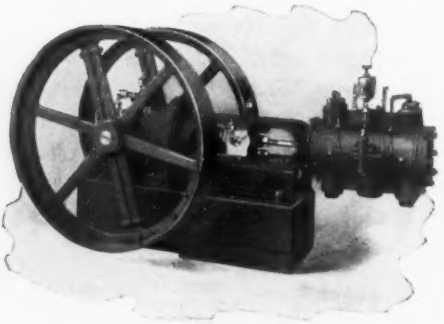
$5 a Year. Ten Weeks for $1

"Probably the highest technical authority in Journalism."—EAGLE, Brooklyn, N. Y.

THE ENGINEERING NEWS PUBLISHING COMPANY.
220 BROADWAY, NEW YORK.

For Small Air Plants

this Sullivan Class WG-3 belt-driven Compressor is especially suited.



Capacity, 100-200 feet per minute

Power—25-30 H. P.

Sectional if desired

Catalogue 53

SULLIVAN MACHINERY COMPANY

Railway Exchange
CHICAGO, ILL.

42 Broadway
New York

Did You Ever Use Press Clippings?

Do you want everything printed in the Newspapers, Magazines and Trade Press of the United States and Canada on any particular subject?

Send us your order, describing what you want us to clip, enclose $2.00 and we will send you our service, for one month, mailing you daily or weekly all clippings found on your topic. We Read and Clip about 25,000 Publications each month.

MANUFACTURERS can learn where there is a market for their goods and how best to reach it.

BUSINESS MEN can obtain reliable tips which lead to business brought in on the follow-up plan.

ANYONE can gather all that is printed about matters of immediate interest, the latest and best thought from many sources.

UNITED STATES PRESS CLIPPING BUREAU
153 La Salle St. Chicago, U.S.A.
.....Send for our Booklet.....

ALL KINDS OF

Molding Machines

In 9 out of 10 cases Stripping Plates are an idle expense.

WHEN NECESSARY, WE USE THEM

THE TABOR MFG. CO.

18th & Hamilton Sts., Philadelphia, Pa.

49 Deansgate, Manchester, England
30-32 S. Canal Street, Chicago, Ill.
84 Mason Building, Boston, Mass.

Fenwick Freres, Paris
Schuchardt & Schutte, Berlin

HOT WATER HEATING
FOR
FACTORIES
BY
FORCED CIRCULATION

Uses Exhaust Steam

Without Back Pressure and Under Vacuum With Condenser

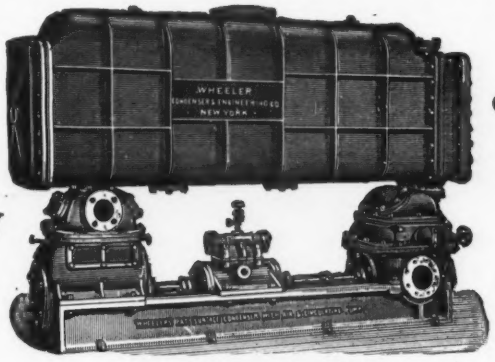
EVANS, ALMIRALL & CO.

281 WATER STREET
NEW YORK

MONADNOCK BLD'G
CHICAGO

WHEELER CONDENSER & ENGINEERING CO.
42 BROADWAY, NEW YORK

For MARINE and STATIONARY SERVICE.



SURFACE CONDENSERS Mounted on Combined Air and Circulating Pumps.

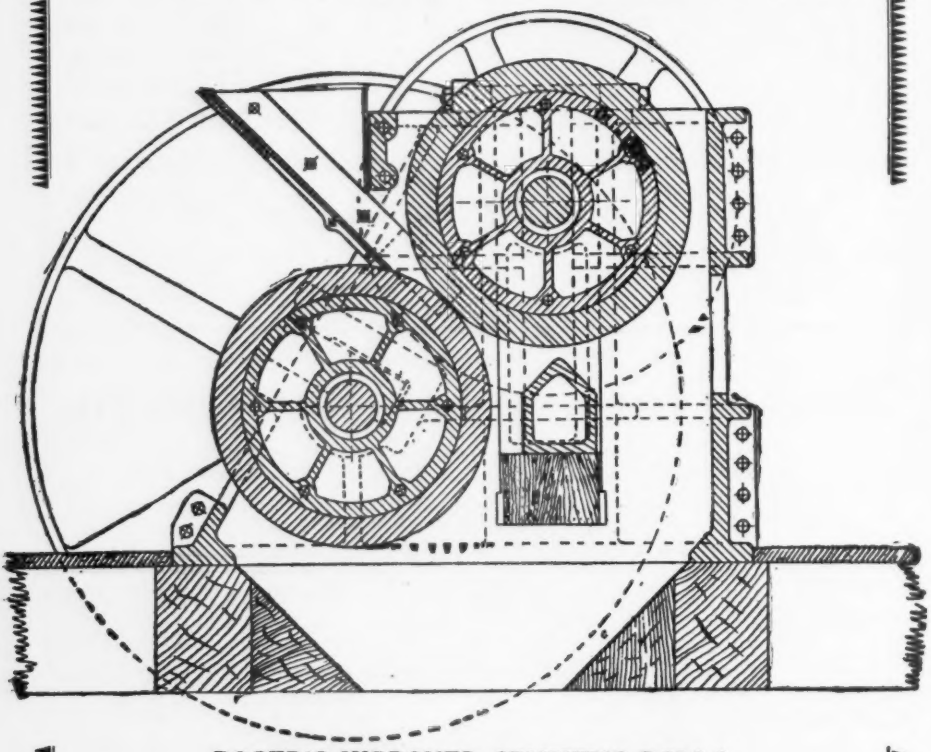
PROPRIETORS AND MANUFACTURERS OF
WHEELER STANDARD SURFACE CONDENSER; WHEELER ADMIRALTY SURFACE CONDENSER; WHEELER LIGHTHALL SURFACE CONDENSER; VOLZ PATENT SURFACE CONDENSER AND FEED WATER HEATER; EDMISTON PATENT FEED WATER FILTER.
WHEELER'S PATENT FEED WATER HEATER

The Stearns-Roger Manufacturing Company,

CONSTRUCTING ENGINEERS.

Chlorination Mills, Electric Plants

Compressed Air Plants of any capacity.



ROGER'S IMPROVED CRUSHING ROLLS.

Patented in the United States and Foreign Countries.

"These Rolls have been running very satisfactorily and appear to us to be unquestionably the best type of roll yet devised. General Manager,
MOLLIE GIBSON & A. J. MILLS, Aspen, Colorado."

Manufacturers of all classes of Machinery for Mining and Metallurgical requirements.

MAIN OFFICE, 1718-24 CALIFORNIA STREET, DENVER, COLO., U. S. A.

THE ENGINEERING MAGAZINE publishes the best original articles by the highest authorities on all phases of current engineering progress.

Additional and exclusive features are: a Review and Topical Index to the current contents of nearly two hundred engineering and industrial journals; Current Record of New Technical Books; Industrial News; latest Improved Machinery and new Trade Literature.

Every number is a valuable reference book for every engineer or student of engineering.

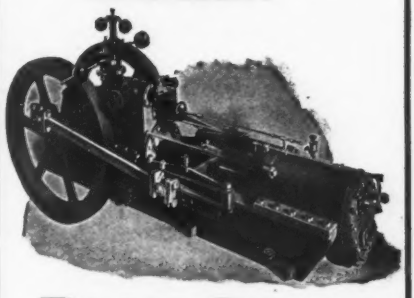
Ask for sample copy and descriptive circular.

THE ENGINEERING MAGAZINE
140-142 Nassau St., New York.

AIR COMPRESSORS

ALL STYLES—ALL SIZES

EMBODYING LATEST IMPROVEMENTS



ROCK DRILLS

McKIERNAN DRILL CO.

170 BROADWAY, NEW YORK CITY

WESTERN REPRESENTATIVES:

CONTRACTORS' SUPPLY & EQUIPMENT CO.
232 FIFTH AVE., CHICAGO

NOW READY

COMPRESSED AIR

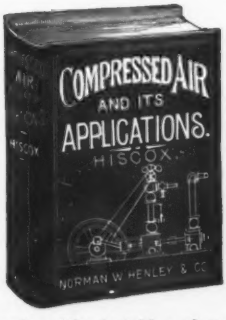
ITS USES AND APPLICATIONS

LARGE 8vo. ABOUT 700 PAGES. 600 HANDSOME ILLUSTRATIONS.

By

GARDNER D. HISCOX, M.E.

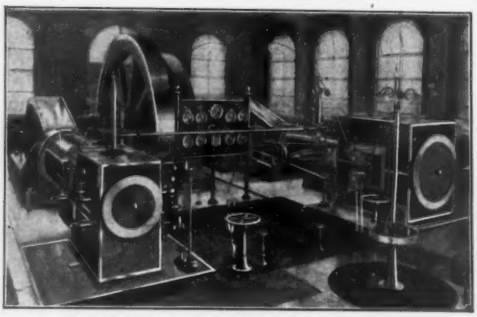
PRICE, $5.00.



A complete treatise on Compressed Air, comprising its physical and operative properties from a vacuum to its liquid form. Its thermodynamics, compression, transmission, expansion, and its uses for power purposes in mining and engineering work; pneumatic motors, shop tools, air blasts for cleaning and painting. The Sand Blast, air lifts, pumping of water, acids and oils; aeration and purification of water supply, are all treated, as well as railway propulsion, pneumatic tube transmission, refrigeration. The Air Brake, and numerous appliances in which compressed air is a most convenient and economical vehicle for work—with air tables of compression, expansion and physical properties. Copies of this book will be sent prepaid to any address on receipt of price. Address

COMPRESSED AIR, 26 Cortlandt St., New York

COOPER-CORLISS ENGINES



FOR ALL POWER PURPOSES

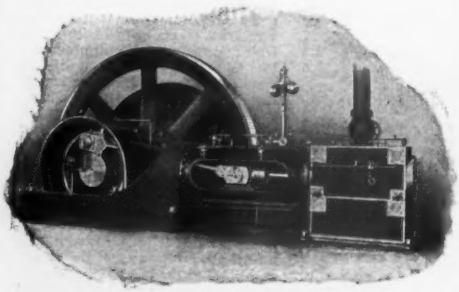
Complete Plants a Specialty

EXCELLENT FACILITIES FOR HANDLING EXPORT TRADE

ESTABLISHED 1833.

THE C. & G. COOPER COMPANY

MT. VERNON, OHIO, U. S. A.



BRANCH OFFICES:

NEW YORK
1023 Havemeyer Building
F. W. IREDELL

BOSTON
411 Weld Building
B. A. CHURCH

ATLANTA
507 Gould Building
E. W. DUTTON

CHICAGO
1436 Monadnock Block
J. HOLT GATES

Do You Want Clean CASTINGS at the Lowest Cost?

IF SO,

The Paxson-Warren SAND BLAST MACHINE

will clean your Castings cleaner than you ever had them.

WILL DO IT Quickly and Thoroughly

J. W. PAXSON CO.
Foundry Outfitters
PHILADELPHIA, PA.

Brown & Seward

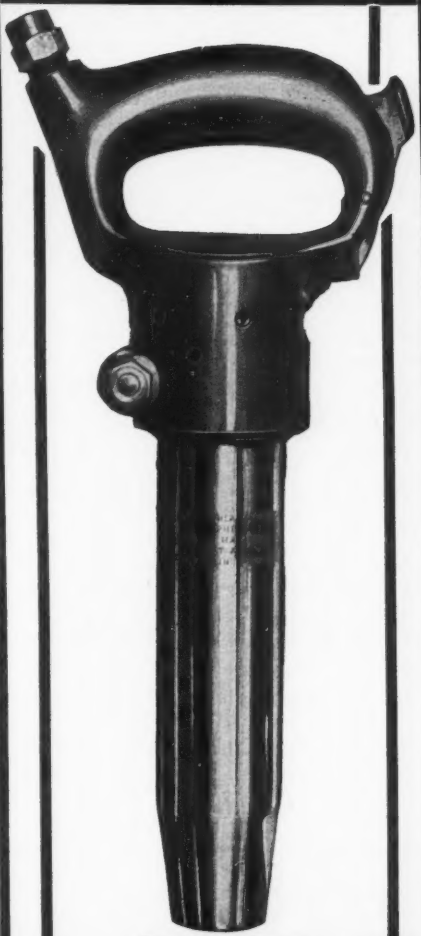
Solicitors of American and Foreign Patents.

Experts in Patent Causes

Offices:
261 Broadway
New York

HENRY T. BROWN
EDWARD C. SEWARD
ROBERT B. SEWARD

THE KELLER



Catalog Free

PHILADELPHIA PNEUMATIC TOOL CO.
21ST ST. & ALLEGHENY AVE.,
PHILADELPHIA.
NEW YORK CHICAGO PITTSBURGH
SAN FRANCISCO BOSTON

The BLAISDELL

Air Compressors

possess distinctively original features in

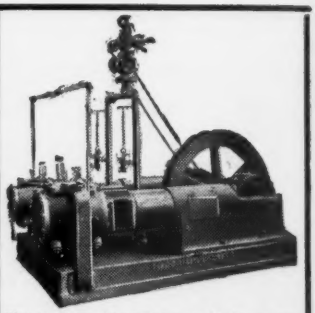
DESIGN, ECONOMY and EFFICIENCY

not found in other makes.

All sizes and types and for any service.

The Blaisdell Machinery Co.,

BRADFORD, PA.



Class F. Steam-driven Two-stage Air Compressor.

Used by the Officers of all Railroads

THE POCKET LIST OF RAILROAD OFFICIALS (ISSUED QUARTERLY) Subscription Price, $1.00 per annum. Advertising rates on application.

THE OFFICIAL RAILWAY EQUIPMENT REGISTER (ISSUED MONTHLY) Descriptive of freight and passenger cars of the Railways and Private Companies in the United States, Canada and Mexico. Subscription Price, $5.00 per annum. Single copies, $1.00.

THE RAILWAY EQUIPMENT & PUBLICATION CO.
24 Park Place, New York.

AIR COMPRESSORS.

SEND FOR
COMPLETE CATALOGUE:

Clayton Air Compressor Works,

114 to 118 Liberty Street,

NEW YORK.

"Compressed Air"

Bound Copies of
VOL. 8
Are Now Ready

Chronicles a year's happenings and inventions in which Compressed Air figures.

$2.00

Forwarded Postpaid on receipt of price

COMPRESSED AIR
26 Cortlandt Street
NEW YORK

Romeike's Press Cutting Bureau

Will send you all newspaper clippings which may appear about you, or any subject on which you want to be "up-to-date." A large force in our New York office reads 650 daily papers and over 2,500 weeklies and magazines, in fact, every paper of importance published in the United States, for over 5,000 subscribers, and, through the European Bureaus, all the leading papers in the civilized globe. Clippings found for subscribers, with name and date of paper are mailed day by day. **Terms, $5.00 for 100.**

BRANCHES: London, Paris, Berlin, Sydney.

HENRY ROMEIKE, Inc.
33 Union Square, N. Y.

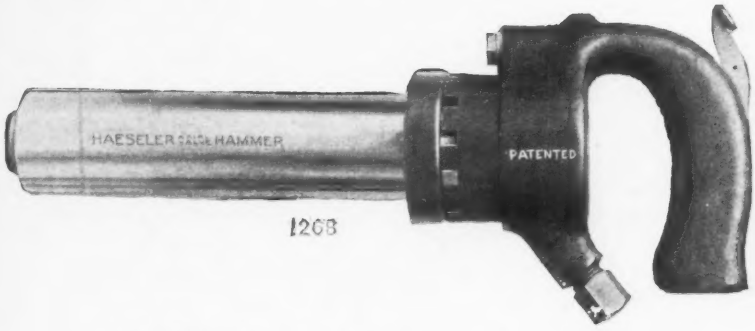
PATENTS

procured promptly and with care in all countries
Trade marks and copyrights registered.

DAVIS & DAVIS,
ATTORNEYS-AT-LAW,
WASHINGTON, D. C.
220 BROADWAY, NEW YORK.

AXIAL VALVE

NOT THE SAME
AS OTHER
Pneumatic Hammers



Explained in "Air Hammer Pamphlet"

Catalog No. 5 Describes Various Types of

"Labor-Saving Tools

OPERATED BY

Compressed Air"

Air Compressors

Rock Drills

Quarrying and Mining Machinery

Pohlé Air Lift

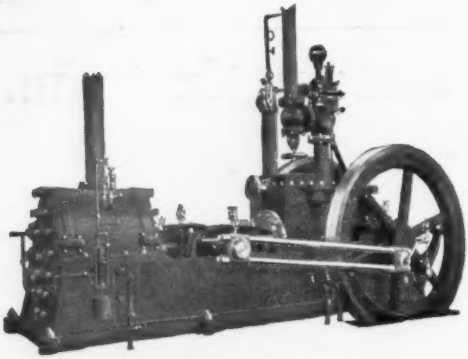
The Ingersoll-Sergeant Drill Co.

CHICAGO, ILL.
CLEVELAND, O.
ST. LOUIS, MO.

26 Cortlandt Street
NEW YORK

PITTSBURG, PA.
PHILADELPHIA, PA.
BOSTON, MASS.

Franklin Air Compressors



MANUFACTURED BY

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: Fisher Bldg., Chicago Eastern Offices: 95 Liberty St., New York

FOR HARD ROCK
THE BABY TORPEDO
A CORLISS VALVE ROCK DRILL
RIX COMPRESSED AIR & DRILL CO.
396 MISSION ST. SAN FRANCISCO CAL.

AMERICAN AIR COMPRESSORS

Send for Catalogue

VACUUM PUMPS, PNEUMATIC TOOLS, HOISTS, ETC.

AMERICAN AIR COMPRESSOR WORKS, 26 Cortlandt St., New York